KEK/J-PARC-PAC 2012-15
July 15, 2012

J-PARC Program Advisory Committee

for the

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

Minutes of the 15th meeting held on
Friday, Saturday and Sunday, 13-15 July 2012

OPEN SESSION (13,14-July-2012):

1. Welcome and Mandate to the committee: M. Yamauchi (KEK)
2. J-PARC status: Y. Ikeda (J-PARC)
3. J-PARC accelerator status: T. Koseki (KEK)
4. E11 status report (T2K): K. Sakashita (KEK), T. Kobayashi (KEK)
5. E14 status report (KOTO): T. Yamanaka (Osaka)
6. E19 status report (High-resolution Search for Θ^+ Pentaquark in $\pi^- p \rightarrow K^- X$ Reactions): M. Naruki (KEK)
7. E27 status report (Search for a nuclear Kbar bound state K^-pp in the $d(\pi^+,K^+)$ reaction): T. Nagae (Kyoto)
8. E10 status report (Study of neutron rich hypernuclei by double charge-exchange reactions): A. Sakaguchi (Osaka)
9. E05 status (Spectroscopic Study of Ξ-Hypernucleus, $^{12}_{\Xi}$Be, via the $^{12}C(K^-, K^+)$ Reaction): T. Nagae (Kyoto)
10. E13 status (Gamma-ray spectroscopy of light hypernuclei): H. Tamura (Tohoku)

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

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

R.S. Hayano (Tokyo)

13. E21status report (COMET): Y. Kuno (Osaka)

14. 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)

15. E34 status report (A New Measurement of the Muon Anomalous Magnetic Moment *g*-2 and Electric Dipole Moment at J-PARC): N. Saito (KEK)

16. Report from high-p beamline workshops: K. Ozawa (KEK)

17. P36 presentation (Measurement of Γ(K→eν)/ Γ(K→μν) and Search for heavy sterile neutrinos using the TREK detector system): M. Kohl (Hampton)

18. E31 presentation (Spectroscopic study of hyperon resonances below $\overline{K}N$ threshold via the (K^{-}, n) reaction on Deuteron): M. Noumi (Osaka)

19. P42 proposal presentation (Search for H-Dibaryon with a Large-Acceptance Hyperon Spectrometer): J. K. Ahn (Pusan)

20. P45 proposal presentation (3-Body Hadronic Reactions for New Aspects of Baryon Spectroscopy): K. Hicks (Ohio)

CLOSED SESSION(13,14,15-July-2012):

Present: E. Blucher, T. Browder, A. Dote, A. Gal*, M. Grosse-Perdekamp,
J. Haba (Chairperson), T. Haruyama (IPNS Deputy Director),
M. Ieiri (Secretary), K. Imai, K. Inoue, K. Kleinknecht,
T. Kishimoto, T. Kobayashi (Secretary), T. Komatsubara (Secretary),
S. Kumano*, W. Louis III, T. Mori*, T. Nagae, Y. Nagai*,
S. N. Nakamura*, H. Sakurai, H. Shimizu, N.Saito (Secretary),
M. Shaevitz*, K. H. Tanaka (IPNS Deputy Director),
K.Tokushuku*, R. Tschirhart*, M. Yamauchi (IPNS Director)

(* invited from the previous committee)

1. PROCEDURE

The minutes of the fourteenth J-PARC-PAC meeting (KEK/J-PARC-PAC 2011-28) were approved.

2. REPORT FROM THE IPNS DIRECTOR

The IPNS director Yamauchi Masanori welcomed the PAC members.

First he summarized the developments that have occurred since the last PAC meeting.

1) Review by a governmental committee to the J-PARC project (March-June 2012), where the urgency of beam power improvement toward the goal of 750kW(FX)/100kW(SX) and the construction of high-p beam line and COMET were confirmed.
2) Budget request submitted to MEXT for JFY2013, which assumes the accelerator upgrade plan will start in 2014 and includes the high-p beam line and COMET construction as the highest priority items in IPNS.
3) Run status since the last PAC meeting

For the period up to summer 2013, the IPNS and IMSS are working to extend the running time to provide sufficient data to the T2K experiment before NOvA turns on and to deliver a significant amount of beam to the SX experiments. The director asked the PAC to evaluate the beam time allocation plan to be presented at the meeting.

Finally he reaffirmed the implication of the recommendations of the PAC (stage 1 and stage 2) stressing that the stage-1 recognition does not imply automatic nor final approval of the experiment. He gave the PAC the following mandates for the 15th meeting.

- E31: examine the request for stage-2 recommendation and consider the appropriate beam time slot in conjunction with E15 and E17.
- P36: evaluate the plan for construction and execution in a limited time slot after stage-1 recognition
- E21: provide critical comments on the revised staged proposal
- P41: examine the background study and suggest a better approach for possible cooperation with the other experiment having the same physics goal.
- P42: examine the request for stage-1 recommendation after an updated report of the preparation status
- P45: evaluate the proposal and provide suggestions to proceed.
- E34: examine the status of R&D activities.

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

3. REPORT FROM THE J-PARC PROJECT DIRECTOR

The J-PARC Center Director Yujiro Ikeda presented the general status of J-PARC. He first reported on the amazing recovery of the facility after the earthquake including the achievement of beam power up to 200kW and 145 kW for RCS and FX, respectively. The PAC praised the heroic and incredibly quick recovery efforts from the disaster and noted the many outstanding results now emerging from the MLF, the Hadron Hall and the T2K experiment.

The PAC also heard about the governmental review held in March-June this year where the J-PARC plan for the coming 5 years was also discussed. The plan includes 1) the power upgrade in the RCS to 1MW and the MR (FX) to 750kW, 2) Neutron facility enhancement, 3) New beam lines for the Muon facility, 4) the High-p beam line and COMET for the Hadron hall, 5) ADS as well as 6) several user and service facilities. He stressed the importance of proper prioritization among the above items.

The director also explained the budget request submitted to MEXT for JFY2013 including the first year of construction of the high-p beam line and COMET in the Hadron Hall.

4. REPORT ON THE J-PARC ACCELERATORS

T. Koseki reported on the status of the accelerators.

He first showed some highlights of accelerator operation since the restart of J-PARC running last December after a 9 month shutdown for earthquake repairs.

Beam delivery was resumed for the MLF from January 24th, for the Hadron Hall from January 28th and for T2K from March 22. The PAC applauded this dramatic resumption of accelerator operation. The total operation time in JFY2011 was 2455 hours including 1210 hours of user time, of which 73.3 % were fully available to users in spite of the unexpected 10 day shutdown due to problems in the HV-PS of the LINAC klystron. The JFY2012 operation starting from April 8th was excellent; beam was provided to the MLF at 215kW, to T2K (FX) at 200kW and to the Hadron Hall (SX) at 6 kW with very high efficiency. During the last three days RCS achieved a record high beam power of 275kW. During a beam study SX beam power was successfully raised up to 14kW. The PAC congratulates J-PARC on these impressive improvements of beam power immediately after the recovery, which provided sufficient POT for the T2K experiment to observe ν_e appearance with 3.2 σ significance.

Koseki explained the current limitations on beam power for FX and SX. There were several problems that restrict operations. One was trouble related to the MR injection kicker, which was fixed during the April 20th maintenance day. The other is related to an excess of radioactivity in the air exhaust line. The accelerator group had to restrict operations to the 160 kW level in order to keep the activity below the permitted level. One of the reasons for the excess was poor air tightness of dampers in an air conditioner system. This problem will be fixed by replacing the dampers during this year's summer shutdown. In addition, another gas leak in the air conditioner system will be investigated during this shutdown. The remaining limitation for FX is the beam loss capacity of the ring collimator section, which limits the beam power to the 200 kW level. On the other hand, SX power is limited by losses in the extraction section. The residual radioactivity after a 6 kW operation was at an acceptable level. After the 2012 summer shutdown SX power will be increased gradually while checking the residual activity.

Koseki showed a possible machine plan with a scheduled long shutdown for the LINAC upgrade from summer 2013, and with an extension of beam time by up to 1.5 months. The PAC recognized this plan as the most effective way to maximize the physics outcomes from both FX and SX experiments.

Finally, he explained the midterm plan for the power upgrade of J-PARC. The upgrade of the LINAC and the installation of an additional ring collimation system with an enhanced shield would enable beam delivery to FX with up to 400 kW by 2014. Several improvements in the beam extraction system and replacement of some SUS beam ducts with Ti would reduce the residual radiation significantly and allow SX beam power up to 50 kW by 2014. Further improvements will be realized by operation at higher repetition rates, which becomes possible with the upgrade of the MR magnet power supplies.

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

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

The PAC was very impressed with the new results presented by T2K at the ICHEP conference. With a total of 3.01×10^{20} POT, T2K now observes 11 ν_e candidate events, compared to a background estimate of 3.22+-0.43 events. This corresponds to a 3.2σ excess of ν_e candidate events and the first 3σ evidence for ν_e appearance on the

atmospheric scale. Assuming $\Delta m^2_{13}=2.4x10^{-3}$ and a normal hierarchy, the best θ_{13} fit gives $\sin^2(2\theta_{13})$ = 0.094+0.053-0.040. For an inverted hierarchy, the best fit gives $\sin^2(2\theta_{13})$ = 0.116+0.063-0.049. The accelerator and the neutrino beam line groups should be commended for recovering from the earthquake and the following horn power supply problem and approximately doubling the number of protons delivered to the experiment since the earthquake in 2011.

Major summer beamline work includes recovery of the expansion joint, preparation of a two power supply configuration for safer horn operation, and improvement of the horn cooling water system. The experiment should start up again by mid-October and preferably earlier. The collaboration requests an extended run of 135 days at >200 kW before the shutdown in summer 2013. This would give T2K a total of about 7.705 x 1020 POT and a θ_{13} sensitivity close to what the Fermilab NOvA experiment expects in the neutrino mode after their first year of running in the summer of 2014. After the shutdown, the collaboration needs to collect >8x1020 POT/year in order to have yearly data rates comparable to NOvA and remain at the forefront in neutrino oscillation physics. Additional physics justification for the POT request should be presented in the next meeting.

The near term goal for T2K is to measure $\sin^2(2\theta_{13})$ with 5σ significance by the 2013 summer shutdown and then move on to a measurement at the 0.01 level by the end of 2015. An appearance measurement holds the promise of exploring not only the values of $\sin^2(2\theta_{13})$ and Δm^2_{13} but also CP violation in the neutrino sector and the mass hierarchy. T2K is in a unique position to provide these appearance measurements over the next couple of years before the NOVA experiment. At the same time, T2K can explore the values of $\sin^2(2\theta_{23})$, which, at present, is known to be large but is not accurately determined. In the longer term, the combination of T2K and NOVA will offer enhanced physics reach when the data sets are combined.

The mixing angle θ_{13} can also be measured by reactor experiments using the disappearance of anti-electron neutrinos. Such measurements are complementary to the T2K measurements, as they only depend on the value of $\sin^2(2\theta_{13})$. The Double Chooz, Daya Bay, and RENO reactor experiments have all announced significant measurements of $\sin^2(2\theta_{13})$, which are consistent with each other and with the T2K measurement. In the next several years, Daya Bay might be able to reach a total uncertainty on $\sin^2(2\theta_{13})$ below 0.01 and provide a precise constraint on the size of this mixing angle.

Comparing and combining the T2K data with the reactor measurements (and with future NOVA measurements when available) will allow more precise probes of neutrino

oscillation physics. By 2015, the T2K $\sin^2(2\theta_{13})$ uncertainty should be at the +-0.01 level and will allow a T2K plus reactor combination to begin to be sensitive to CP violation effects. In later years, combinations of T2K, NOVA, and reactor measurements could possibly have sensitivity to the mass hierarchy as well as CP violation effects. Therefore, it is now important for the collaboration to present quantitative studies of the potential impact of T2K data in combination with reactor measurements and NOvA at the next PAC meeting.

The PAC supports the request by T2K for 135 days of running at >200kW prior to the 2013 summer shutdown. The requested 1.5 month run extension, which will also be beneficial to all the SX experiments including KOTO, will give T2K a total of approximately 7.7x 1020 POT and, as stated before, sensitivity to $\sin^2(2\theta_{13})$, which is comparable to that expected by the NOvA experiment in neutrino mode. In addition, the PAC suggests that the T2K collaboration study the possibility of reducing backgrounds and their uncertainties by using measurements from the near detector (ND280). Any reduction of backgrounds would increase the significance of the $\sin^2(2\theta_{13})$ measurement. Other avenues to study include the optimization of the selection criteria and increasing the T2K acceptance and efficiency by optimizing further the analysis procedure. In order to assure the maximum utilization of the neutrino beam, the PAC recommends that the T2K collaboration and the J-PARC facility prepare backups for all of the critical technical systems.

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

The committee was impressed with the group's progress in preparing their detector for the upcoming runs. The group has requested a short physics run (~ 2 weeks) in March 2013 followed by a 1 month period for analysis and repairs. The main physics run request is for 30 days at 15 kW plus an additional five days. If no events are observed, this exposure will result in a 90% c.l. upper limit below the Grossman-Nir limit $BR(K_L \rightarrow \pi^0\nu\nu) < 1.4\times10^{-9}$. The PAC endorses the KOTO run request, and strongly supports the goal of reaching the Grossman-Nir limit before the 2013 summer shutdown. This goal is part of the motivation for the proposed extension of 2013 running time.

KOTO's June 2012 run demonstrated the successful operation of the DAQ system and digital trigger with optical fiber readout. It also included a successful test of the charged

veto system. Their tests have revealed problems with cable outgassing damaging the UV transparency of silicon cookies used to couple the CsI crystals to phototubes. The group is working to find acceptable replacement cables.

Before the December 2012 engineering run, the group must fabricate and install the neutron collar counter, install the main barrel vessel in the experimental area and install the remaining barrel veto modules, and reinstall PMTs for the CsI calorimeter. There is a lot to do, but the group appears to be well organized to take advantage of the proposed data taking period.

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

The PAC has heard the recent result of E19 experiment, which aims to search for an exotic pentaquark state Θ+ via the hadronic reaction π^- p -> K^- X at the K1.8 beam-line using the SKS magnet.

In October – December 2010, the first data run of E19 was performed at a pion beam momentum P_π= 1.92GeV/c. This was the same momentum as that of the preceding experiment, KEK E522, in which an enhancement was observed at ~1530 MeV/c^2 with 2.5σ significance. First, the spectrometer performance was checked with Σ^+ and Σ^- measurements. These confirmed that good mass resolution was realized for the Θ+ region; ΔM= 1.4MeV/c^2. A data sample of 8.7 x 10^{10} beam pions on target was recorded. No significant peak structure was observed in the missing mass spectrum. An upper limit on the Θ+ production cross section of 0.26μb/sr was obtained, which is ten times better than that of KEK E522 (2.9μb/sr). With the help of a theoretical model, the upper limit on the decay width of the Θ+ was estimated to be 0.72MeV (3.1 MeV) for $J^p=1/2^+$ ($1/2^-$) case.

In February 2012, a second run was taken at P_π= 2.0 GeV/c which is the maximum beam momentum for the K1.8 beam line. This was the first experiment after the big earthquake in March 2011. In this measurement all sub-detectors were confirmed to work correctly also after the earthquake; the spectrometer performance was maintained at the same level as in the first data run. A preliminary result obtained from the data sample of 8.7 x 10^{10} beam pions on target was shown at the PAC. Results from the new data are expected to be reported soon.

The result of the first data run will appear in Physical Review Letters. The PAC congratulates the E19 group on the success of their first data run. The PAC also appreciates their efforts to perform a second round of data taking just after the earthquake.

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

The PAC heard a report on preliminary results obtained in the E27 pilot run.

The E27 program aims to search for a K-pp bound state produced via the d(π+, K+) reaction. In June 2012, the E27 group organized a pilot run to obtain the inclusive spectrum for the reaction study and to check the feasibility of coincidence measurement with one or two protons. The spectrum allows to evaluate the maximum value of production cross section and to understand the background shapes.

The pilot run was successfully completed as scheduled to take two sets of physics data for d(π+,K+) at 1.7 GeV/c (2 M π/spill for 7.6 days) and p(π+,K+) at 1.7 GeV/c (2.5M pi/spill for 15 hours), and calibration data of p(π+,K+)Σ+ at 1.58 GeV/c (2.5 Mpi/spill for 8.2 hours). The Range Counter Array worked well and was used for coincidence measurements with protons to suppress quasi-free backgrounds in the missing mass spectrum.

In a preliminary analysis, the missing mass resolution for the Σ+ was found to be 2.3 MeV/c^2. The yields for the Σ+ and Σ+(1385) were measured and the Σ+(1385) yield was found to be 30% lower than expected. The inclusive missing mass spectrum in d(π+,K+) was consistent with a simulated one. Further analysis is underway to check the feasibility of the coincidence measurement.

The PAC congratulates the E27 group for the success of their pilot run, and expects that on-going analysis will give a value of production cross section and a background-suppression via the coincidence measurement technique.

5. **E10:** (Study of neutron rich hypernuclei by double charge-exchange reactions)

E10 aims at studying the (π^-, K^+) reaction on ^{6}Li and ^{9}Be targets to measure $^6_\Lambda$H and $^9_\Lambda$He, respectively. The PAC heard the current status of the experiment. The progress looks reasonable and the experiment is almost ready to take data. In

practice, the pion beam intensity is not limited by beam power but rather by the rate capability of the detector.

The PAC encourages the experimental group to further improve their detector to tolerate higher beam intensity. The PAC also appreciates the effort of the accelerator group to improve the duty factor of the beam so that a higher beam intensity can be tolerated.

The proponents emphasize the importance of $^{6}_{\Lambda}$H. This appears reasonable although the importance of $^{9}_{\Lambda}$He was emphasized by the last PAC. Recently, observation of $^{6}_{\Lambda}$H was reported by a stopped K^- experiment at FINUDA. An independent confirmation is highly desirable.

6. **E05:** (Spectroscopic Study of Ξ-Hypernucleus, $^{12}_{\Xi}$Be, via the ^{12}C(K^-, K^+) Reaction)

This experiment was selected as the 1st priority experiment among the five Day-1 experiments to be conducted in the Hadron Hall at the first PAC meeting. The experiment studies the spectroscopy of the ^{12}C(K^-,K^+) reaction to look for X hypernuclei as bound state peaks for the first time. The K1.8 beam line was constructed to meet the requirements for this experiment. In particular, the experimental design assumed the full beam power of 270 kW on a Ni target delivering 1.4x10^6 K^- beam/spill.

A new spectrometer called SKS+, which has about 30 msr acceptance, was prepared by adding a small dipole magnet in front of the SKS magnet. However, the present beam power of 6 kW available at the Hadron Hall does not provide enough K^- intensity for this experiment. Depending on the K^- beam tuning on the K1.8 beam line, the intensity is estimated to be 4.5x10^5 K^-/spill at 1.8 GeV/c even with 30 kW beam power. At this intensity, the production yield would be 40 events in 30 days, which is only 1/5 of the yield in the original proposal. Therefore, the E05 group proposes to operate in the single SKS mode with a 110 msr acceptance, while the estimated energy resolution of 4 MeV (FWHM) would be a bit worse than the 3 MeV of the SKS+ configuration. In this mode, about 100 events are expected in 30 days, which might be sufficient to observe the bound state structures. Since this would be the last chance to use the SKS at the K1.8 beam line before the LINAC upgrade, the PAC believes it is important to attain this goal.

The Committee recommends that IPNS should continue the effort to realize sufficient K beam intensity to conduct this high priority experiment.

The experimental group is now constructing a new spectrometer, S-2S, replacing the SKS, by using the Grant-In-Aid awarded last year. The S-2S will have a much better energy resolution of 1.5-2 MeV (FWHM) and a modest acceptance of around 60 msr. It is designed to study the fine structure in the Ξ and ΛΛ hypernuclei. Thereby, the strangeness -2 baryon system will be fully investigated. The S-2S is scheduled to be installed at the K1.8 beam line in 2015. The PAC endorses this upgrade of the SKS system.

7. **E13:** (Gamma-ray spectroscopy of light hypernuclei)

A status report on E13, one of the top priority experiments, was presented. The PAC is impressed with the Hyperball-J system working very well for a 1M/spill 0.8 GeV/c π^+ beam with PWO Compton suppression. The whole system will be moved from Tohoku University to J-PARC in August and will be ready by the end of 2012.

The E13 group separates their experiment into phase 1 and phase 2 to meet the present situation of the SX beam and requests the phase 1 run before the long shutdown scheduled next summer. In phase 1 they intend to study important physics issues such as the long-standing puzzle on charge symmetry breaking in the Λ-N interaction from ${}^{4}_{\Lambda}$He and the mass number dependence of the Λ-N spin-spin interaction from ${}^{19}_{\Lambda}$F. These experimental results can be obtained even with a beam of 10kW for 30days. The PAC endorses this program. An appropriate beam arrangement will be discussed in the next PAC meeting.

In phase 2, the E13 group plans to measure the g-factor of Λ in a nucleus as well as to study the ΛN-ΣN interaction. The PAC recognizes that the physics of the former measurement is quite compelling and the experimental sensitivity is well estimated. The proposed phase 2 will be conducted downstream of the K1.1 beam line with the SKS moving in from the K1.8 beam line. The PAC supports the two-stage approach.

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

The experimental group reported the results of an engineering run with the full setup carried out in this June. A quick preliminary analysis of the initial data shows that

all detectors are working as expected. The PAC appreciates the effort of the E15 group to start the experiment. The experiment is ready to take data.

The PAC awaits further analysis of current experimental data to confirm the performance of the apparatus. The experiment might give some hints about the properties of the K^-pp system.

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

   The PAC heard the current status of the experiment. There have not been many changes to be noted here but the PAC appreciates that the experiment is almost ready to take data. The experimental group requests three months to switch over from E15. The PAC notes that a shorter switch over time may allow more flexibility in the beam allocation.

10. **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 expected by many well-studied new physics models such as SUSY-GUTs in a perspective different from the LHC. As such COMET could become one of the flagship experiments for J-PARC and Japanese physics later in the decade.

    The PAC was pleased to learn about a breakthrough in the two major challenges: muon capture efficiency and beam pulsing. An increase of about a factor of 10^3 has been demonstrated at the pion capture system with MuSIC at RCNP in Osaka. The achieved value of the proton extinction factor, 3×10^{-11}, is well below the required value of less than 10^{-9}.

    The COMET experiment takes a staged approach with two phases. Phase-I uses a

    90 degree bend only for the muon beamline and a straight electron detector.

    Phase I still has to choose a technology: either a cylindrical drift chamber or a straw tube transverse tracker. Phase-I is designed as a background study in preparation for phase-II, but, at the same time it will have two orders of magnitude better sensitivity than the current limit. The single event sensitivity for phase-I has been reevaluated

as $3x10^{-15}$ for the measured proton extinction factor and an updated background estimation of 0.03.

It was also noticed that Mu2e at Fermilab, which will have a sensitivity similar to COMET phase-II on a similar time scale, recently received DOE CD1 (Critical Decision 1) approval. It is important to maintain the schedule of COMET to be competitive. The funding situation of COMET phase I beamline will be known by the end of 2012. A more realistic schedule of COMET should be made at the next PAC meeting in January 2013. The PAC requests that COMET submit its technical design report (TDR) for the phase-I with a technology choice for the baseline detector design. The TDR should have a technical review by experts. The PAC notes that additional effort to obtain necessary funding for the detector system should be made.

11. **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 DeeMe experiment aims to improve the experimental sensitivity for detecting muon-to-electron conversion by two orders of magnitude below the current measured limit down to 10^{-14} with the pulsed proton beam from RCS. The physics importance is very clear. There was good progress in the measurement of the after-proton ratio at the level of 10^{-17} to 10^{-19}, which is satisfactory for the experiment, and also in the preparation of the H- line. The new target, the SiC rotating target, is now planned instead of the current graphite fins target and is beneficial for both the DeeMe and g- 2/EDM (P34) experiments. However, it does have a small effect (5-10%) on the downstream neutron facility and negotiation among the persons concerned is necessary.

DeeMe is funded by KAKENHI(S) for the period from 2012 to 2016 and stage-1 approval has been given by IMSS. The development of the prompt kicker has been started under the framework of the US-Japan cooperation program. On the other hand, the COMET experiment (E21), which will have two orders of magnitude better sensitivity, already has stage-1 approval by the PAC. It will become one of the flagship experiments for J-PARC and Japanese physics later in the decade. The two experiments use different beam lines and hence there is no beam time conflict.

However, the PAC notes that an important fraction of the membership is shared between the two experiments, and this might cause difficulty in advancing both

experiments forward in a timely manner. The PAC endorses the physics goal of both experiments and encourages them to cooperate to realize the best sensitivity for mu-e conversion.

12. **E34:** (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/EDM collaboration. 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 (EDM) of the muon reaching a limit of $d_\mu=1.0\times10^{-22}$ e·cm. The proposed measurement will improve the precision of the previous E821experiment at BNL 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 as compared to the E821 limit of $d_\mu<1.9\times10^{-19}$ e·cm. Measurements of g-2 and the EDM of the muon at high precision could provide important insights into the nature of the dynamics of physics beyond the Standard Model.

    The collaboration reported R&D activities for instrumentation projects that align with the critical project milestones formulated in the g-2/EDM CDR presented to the PAC in January 2012.

    These include the cold muonium production using the surface muon beam in the H-line, the reacceleration of positive muons, the injection of the muon beam into the high-precision superconducting muon-storage magnet, the storage magnet systems including the precision field measurement instrumentation and the decay positron detection systems.

    The PAC observes the excellent progress the g-2/EDM collaboration continues to make in all areas of R&D. The most notable results presented included new ideas to increase the cold muonium yield from the muon stopping target by a factor of 8, the acquisition of components of the re-acceleration systems and progress in the simulation of these systems. The increase in muonium yield results from improvements in target geometry and higher surface muon yields from a new primary production target.

    The PAC notes that the successful realization of the experiment still requires major advances of experimental technology and significant resources to pursue the challenging R&D tasks. High priority steps include the demonstration of the ionization yields of the cold muonium cloud downstream of the stopping target with

the high power laser system and the evaluation of the beam phase space widening during re-acceleration in simulation and experiment. The PAC emphasizes that the success of the experiment requires continuous high levels of support for the R&D effort from IPNS as well as timely construction of the H1 beam line in MLF. The PAC is looking forward to reviewing the R&D progress for g-2/EDM in January 2013 and recommends a presentation that includes a detailed analysis of the R&D project schedules and identification of the critical resources needed to meet the project schedule.

13. **E31:** (Spectroscopic study of hyperon resonances below $\overline{K}N$ threshold via the (K^-, n) reaction on deuteron)

This proposed experiment studies the I=0 Λ(1405) resonance with in-flight K^- initiated production reactions, such as d(K^-,n), in order to confront and supplement other in-flight data, in particular the recent electromagnetic production reaction data from SPring-8 and from JLab. This should help resolve the nature of the Λ(1405).

The proponents described the readiness of the experimental apparatus which is nearly the same as the one used for E15 except for the target. They also reported the performance of the liquid deuteron target and additional detectors. The PAC also heard a report from E15 about their detector performance observed in the recent run. The PAC has confirmed the readiness of the experimental apparatus. The proponents showed the expected yield for three Λ(1405) decay channels for the proposed beam time request of 40 days with a 27 kW proton beam. However, it is not clear how well the experiment can clarify the nature of the Λ(1405) such as the pole position of the KN bound state using the expected statistics of its spectra. The PAC requests that E31 clarify this point in order to justify the requested beam time before a stage 2 recommendation.

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

As discussed in the previous PAC meeting minutes, the collaboration proposes to improve the measurement of the helicity suppressed ratio R = $\Gamma(K\rightarrow e\nu)/\Gamma(K\rightarrow\mu\nu)$, which is an excellent probe of physics beyond the Standard Model. The authors propose to improve by a factor two on the best previous measurement by the

NA62 collaboration at CERN, which has achieved a relative uncertainty of 4 x 10^-3, equally split between statistical and systematic components, with a measured value of Rexp= (2.488±0.010) x 10-5. This value differs by one standard deviation from the theoretical standard model value. A larger deviation from the prediction could indicate the existence of new physics.

The P36 proponents propose to improve on the NA62 measurement by collecting 250,000 $K \rightarrow e \nu$ (Ke2) decays at rest with an optimized evolution of the existing KEK-PS E246 detector. The P36 experiment is further motivated by the fact that the systematic uncertainties in this stopped kaon experiment are completely different from those in the NA62 decay-in-flight experiment. The P36 experiment also could have interesting sensitivity to heavy sterile neutrinos, which further motivates the physics case.

In the PAC14 meeting, the committee urged the proponents to present a plan to show how the experiment could be run in late JFY2014 before work for the COMET beam line starts in early JFY2015. Furthermore the PAC suggested an investigation how the cryogenic infrastructure for P36 could be used for COMET in its phase 1. This question was answered positively by the laboratory.

The P36 proponents have answered the questions raised in the PAC14 meeting about how they want to realize the experiment within the restricted time schedule imposed by the necessity to begin work on the COMET beam line. Provided that funding comes in a timely manner, the schedule for setting up the experiment seems feasible, but challenging. In addition, the identified manpower seems appropriate. Concerning the cryogenic system for P36, the PAC heard a presentation on how the system could be used also by the COMET phase 1 project. The current schedule does present an opportunity in 2014 to run the P36 experiment, at least for part of the program. The PAC suggests that the laboratory and collaboration remain flexible about the schedule in case it becomes possible to add beam time for the sterile neutrino search. It should be noted that the precise understanding of the detector required for the RK measurement (control of the systematics at the 0.16% level) is not needed for the neutrino search.

The PAC continues to endorse the physics case and stage-1 status and looks forward to hearing a progress report on preparation and funding at the PAC meetings in 2013.

15. **P42:** (Search for H-Dibaryon with a Large-Acceptance Hyperon Spectrometer)

The PAC heard a report from the proponents, which answered the questions raised in the 13th PAC meeting.

To optimize the target, they carefully considered the nuclear absorption processes in the target nucleus and the detector acceptance for ΛΛ events, and came up with a new design consisting of a diamond target 15-mm long. They found that they would gain approximately a factor of three in the signal yield as compared with the original Cu target. This proposal is also supported by background considerations.

A more complete design of the new large-acceptance hyperon spectrometer, HypTPC, including the detailed GEM-pad design, magnetic field calculations for the Helmholtz and KURAMA magnets was presented. The performance of the detectors such as momentum resolutions, mass resolutions for ΛΛ events were simulated with a GEANT4 based code. The final sensitivity achieved in the the H search was based on these simulations. In the resonance region, $H \rightarrow \Lambda\Lambda$, P42 is sensitive to 1 nb/sr - 1μb/sr, and in the bound region, $H \rightarrow \Lambda p\pi^-$, a few nb/sr, which is close to two orders of magnitude improvement from the present limit. The sensitivity in the resonance case depends on the width of the state.

The PAC was convinced that the goal of the experiment is now clear and it will have very significant impact on hadron physics. The PAC also heard that they have recently obtained enough funding to construct the HypTPC system both in Japan and in Korea. Therefore, the PAC recommends that the proposal obtain Stage-1 status. The committee expects the proponents to report on the status of the GEM-pad R&D and the development of the readout electronics for the HypTPC at appropriate times.

16. **P45 (**3-Body Hadronic Reactions for New Aspects of Baryon Spectroscopy**)**

This proposal aims to record high precision data on the πN-> ππN reaction to study nucleon resonances including possible hybrid baryons using the K1.8 beamline and the same TPC spectrometer to be used for P42. The proponents stressed the necessity of high precision data on this reaction to complete recently developed coupled-channel analyses of nucleon resonances. This was suggested by the analysis

groups which have worked for the analysis of high precision data of recently obtained with photon beams such as at Jlab. The possible existence of hybrid baryons suggested by lattice QCD calculation is quite interesting. At the same time $\pi p \rightarrow K^{+}Y$ data can also be obtained. At present, the $\pi N \rightarrow \pi\pi N$ database consists of a few measurements done in 1970's with limited statistics. To take full advantage of the recent progress of theoretical work in lattice QCD and dynamical coupled-channel model etc., the proponents propose to completely renew the database by using the high-intensity pion beams available at J-PARC.

The PAC understands the importance of determining the nucleon resonance spectrum. This kind of effort will enhance the cooperation between the hadron physics program at J-PARC and the efforts at other hadron physics laboratories such as JLab. The PAC asks the proponents to answer the following points before promoting to a stage-1 status,

1. The proponents should provide more quantitative argument to show how the data of expected precision will contribute to the analysis of nucleon resonances.
2. The proponents should show how well the measurement of proposed reactions can be made in a full simulation.
3. The proponents should show more details about the modification of the detector system to be built in P42.
4. The proponents should discuss with P42 how they can contribute to the detector construction.

17. **Report from high-p beamline workshops**

The PAC heard a report from a domestic workshop where several physics potential of the high-p beam lines were discussed including the hadron mass shift experiment like E16 or charmed baryon spectroscopy for hadron structure study as well as study on η' production, Drell-Yan process or $K^{-}K^{-}pp$ bound states. The PAC considers further intensive studies of the physics cases in the broader scope are extremely important and suggests IPNS to have a larger scale discussion in a global workshop with researchers in the related fields as well as theory.

6. EVALUATION OF TEST BEAM EXPERIMENT

The PAC chairperson reported on the evaluation of a new test beam proposal, P44 (Study of in-beam performance of Hyperball-J Ge detector units with the current beam

structures at the K1.1BR beam line), which was received during the time after the previous meeting. To address this proposal, a meeting of the Test Experiment Committee was held on May 21st in 2012. The members were Junji Haba (the PAC chairperson), Takashi Kobayashi (the leader of the particle and nuclear physics division of J-PARC), and Masaharu Ieiri (a member of the JPNC and a consultant for the capabilities and schedules of the hadron hall beam lines). It was agreed to arrange the beam time for P44 in June 2012, and the test beam experiment was performed at K1.1BR. The PAC agreed the decision of the Test Experiment Committee. .

7. RECOMMENDATIONS FOR BEAM TIME ASSIGNMENT AND PLANNING FROM OCTOBER 2012 TO THE SUMMER 2013

T2K reported evidence of ν_e appearance at the 3.2σ level with the data taken before the summer of 2012, and requested to deliver another ~5 x 10^{20} POT by the next summer shutdown to reach ~8 x 10^{20} POT in total, which would leads to a 5σ appearance signal for the case of $\sin^2(2\theta_{13})=0.1$ and $\delta=0$. This ensures that T2K will firmly establish ν_e appearance before the NOvA experiment at Fermilab starts producing results. Assuming a conservative beam power of 206kW, the requested POT corresponds to 135 days (170 days taking machine running efficiency of 80% into account).

The PAC heard detailed status reports from the fully approved (stage-2) experiments in the queue at the Hadron hall: E05, E10, E13 at the K1.8 beam line, E15, E17 at the K1.8BR beam line, and E14 at the KL beam line. Proponents explained their possible running plans before the long summer shutdown of 2013. E14 will be ready to receive the next beam at the beginning of December; they requested three short runs and a 30-day physics run before the next summer shutdown to reach the Grossman-Nir limit with the physics run, assuming an attainable beam power of 15kW. The K1.8 and K1.8BR experiments will be ready for data taking in the autumn of 2012, and requested 94 days in total for production runs assuming a 15kW beam. E05, E10 and E13 plan to use the SKS at K1.8 before the summer shutdown of 2013. The SKS will be replaced by KURAMA, with which the E03 and E07 experiments should be performed in the time slot before the S-2S spectrometer is installed in future.

In order to cope with these requests from SX and FX experiments, IPNS proposed to:

1) increase the MR user beam time by ~1.5month before the summer shutdown of 2013 by converting the following no-beam periods into user beam time:
   - the break in the year end (December 2012) and new year (January 2013),
   - the break in the fiscal-year end (March) and beginning (April), and

- the month of July 2013, and

2) allocate the user beam time, including the extension above, to SX and FX in the ratio of 1:2.

LINAC upgrade work, which was originally scheduled to start from July 2013, will be delayed by 1 month, which consequently leads to a delay in restarting accelerator operation by 1 month.

With this extension of user beam time, a total of ~236 days (including MR study) can be allocated to the experiments. With SX:FX sharing in the ratio 1:2, T2K can accumulate 7.7×10^{20} POT before the summer of 2013. The SX experiments can run for nearly 80 days in total, which allows the KOTO experiment in particular to go beyond its first milestone, the Grossman-Nir limit, and start exploring new physics. Most of the requests from the experiments at K1.8 and K1.8BR can also be satisfied. The T2K, KOTO and K1.8/K1.8BR experiments will produce JPARC physics results with large and world-wide physics impact from the data taken before the summer shutdown of 2013.

The PAC strongly supports the IPNS proposal to increase the machine operation time. Both IPNS and J-PARC should make every possible effort to achieve this goal. The PAC also supports the beam plan shown by the lab. The PAC endorses the plan to carry out the pion based experiment E10 at first by gradually increasing the beam power. While this scenario is based on the assumption of 15kW for SX and 206 kW for FX, the PAC reiterates the need to make further efforts to increase the beam power.

The detailed run schedule after February will be discussed and experiments to be performed at K1.8 and K1.8BR should be prioritized at the next PAC meeting taking into account the accelerator running performance and the expected beam power by then.

8. DATES FOR THE NEXT J-PARC PAC MEETINGS

The next PAC meeting will be held on 9-11 January 2013.

The PAC would like to hear the run status of the experiments after the summer shutdown 2012. The beam time allocation in 2013 will be reevaluated as appropriate.

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

- Minutes of the 14th J-PARC PAC meeting held on 16-17, March 2012 (KEK/J-PARC-PAC 2011-28)
- Proposal for J-PARC 50 GeV Proton Synchrotron: Study of in-beam performance of Hyperball-J Ge detector units with the current beam structures at the K1.1BR beam line (KEK/J-PARC-PAC 2012-1)
- Letter of Intent for J-PARC 50 GeV Proton Synchrotron: γ-ray spectroscopy of a well deformed sd-shell nucleus: ${}^{25}_{\Lambda}\mathrm{Mg}$ (KEK/J-PARC-PAC 2012-2)
- Proposal for J-PARC 50 GeV Proton Synchrotron: 3-Body Hadronic Reactions for New Aspects of Baryon Spectroscopy (KEK/J-PARC-PAC 2012-3)
- Proposal of a practice experiment using a hadron beam for EDIT 2013 (KEK/J-PARC-PAC 2012-4)
- Progress Report of P36: Measurement of $\Gamma (K^+ \rightarrow e^+ \nu) / \Gamma (K^+ \rightarrow \mu^+ \nu)$ and Search for heavy sterile neutrino using the TREK detector system (KEK/J-PARC-PAC 2012-5)
- Status Report on the Experimental Search for μ-e Conversion in Nuclear Field at Sensitivity of 10^{-14} with Pulsed Proton Beam from RCS -DeeMe(P41) (KEK/J-PARC-PAC 2012-6)
- A Reply to the 13th J-PARC PCA Review on the Proposal P42 (KEK/J-PARC-PAC 2012-7)
- The preparation status for the E31 experiment (KEK/J-PARC-PAC 2012-8)
- P31 Proposal, Revised in July 2012 (KEK/J-PARC-PAC 2012-9)
- Experimental Proposal for Phase-I of the COMET Experiment at J-PARC (KEK/J-PARC-PAC 2012-10)

- Cryogenic System for the TROIDAL magnet and the COMET experiment (KEK/J-PARC-PAC 2012-11) (internal)
- Development Plan and Cost Estimation of Cryogenics for P36 and E21(COMET) (KEK/J-PARC-PAC 2012-12) (internal)
- Run Summary and Run Plan for Slow Extraction (KEK/J-PARC-PAC 2012-13) (internal)
- Status report of P36 (KEK/J-PARC-PAC 2012-14) (internal)