Approved in the 23rd PAC meeting
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July 27, 2016

J-PARC Program Advisory Committee

for the Nuclear and Particle Physics Experiments

at the J-PARC Main Ring

Minutes of the 22nd meeting held on
27(Wed)-29(Fri) July 2016

OPEN SESSION:

1. Welcome and Mandate to the Committee:	K. Tokushuku (KEK)
2. J-PARC Center Report:	N. Saito (J-PARC/KEK)
3. J-PARC Accelerator Status & Plan:	F. Naito (J-PARC/KEK)
4. E11 (T2K):	Mark Hartz (IPMU/TRIUMF)
5. P65 (Proposal for T2K Extended Run):	T. Nakaya (Kyoto)
6. P61 (NuPRISM):	M. Wilking (Stony Brook)
7. E56 (Sterile ν Search):	T. Maruyama (J-PARC/KEK)
8. Hadron Hall Status, Schedule, and Target R&D Plan	T. Komatsubara (J-PARC/KEK)
9. E14 (KOTO):	T. Yamanaka (Osaka)
10. E36 (Lepton Universality):	S. Shmizu (Osaka)
11. FIFC Report:	S. Uno (KEK)
12. E34 (g-2/EDM):	T. Mibe (J-PARC/KEK)

13. E63 (Gamma-ray Spectroscopy of Light Hypernuclei):

H. Tamura (Tohoku)

14. E50 (Charmed Baryon): H. Noumi (Osaka)

15. E31 (Hyperon Resonances below KN Threshold): H. Noumi (Osaka)

16. E62 (Precision Spectroscopy of Kaonic Atom X-rays with TES):

S. Okada (RIKEN)

17. E57 (Strong Interaction Induced Shift and Width of Kaonic Deuterium):

J. Zmeskal (SMI)

18. E40 (Measurement of the Cross Sections of Σp Scatterings):

K. Miwa (Tohoku)

19. E05 (Ξ Hypernucleus): T. Nagae (Kyoto)

20. E07 (Double Strangeness System with a Hybrid Method):

K. Nakazawa (Gifu)

21. E03 (Measurement of X-rays from Ξ-Atom): K. Tanida (JAEA)

22. E21 (COMET): Y. Kuno (Osaka)

23. E16 (Measurements of Spectral Change of Vector Mesons in Nuclei):

K. Aoki (J-PARC/KEK)

24. Beam Time Schedule in 2016-2018 T. Kobayashi (J-PARC/KEK)

CLOSED SESSION:

Present: N. Aoi (Osaka/RCNP), E. Blucher (Chicago), T. Browder (Hawaii), S. I. Eidelman (BINP), J. Haba (Chair/KEK), K. Hanagaki (KEK/Osaka), D. Harris (FNAL), T. Hatsuta (RIKEN), S. Kettel (BNL), R. Kitano (KEK), M. Kuze (Tokyo Inst. of Tech.) , W. Louis III (LANL), J. Pochodzalla (Mainz), W. Weise (TU Munich), H. Tamura (Tohoku), W.A. Zajc (Columbia), K. Tokushuku (IPNS Director),

T. Kobayashi (IPNS Deputy Director), and N. Saito (J-PARC Director)

Apologies: G. Isidori (UZH)

1. PROCEDURAL REPORT

The minutes of the 21st J-PARC-PAC meeting (KEK/J-PARC-PAC 2016-11) were approved.

2. LABORATORY REPORT

2-1 Welcome and Mandate to the Committee (Katsuo TOKUSHUKU, KEK IPNS director)

The director of the Institute of Particle and Nuclear Studies (IPNS), Katsuo Tokushuku, welcomed the PAC members.

Tokushuku reported on the renewal of the committee membership, and expressed his appreciation to the members who completed their term. The charge of the J-PARC PAC and the approval process of the experimental proposals were explained. A summary list of experimental proposals and on-going experiments was presented. The recent improvement of beam power to a level greater than 400 kW and ~40 kW for the MR-FX and the MR-SX, respectively, was reported. The consolidation work at the facilities and the arrangement of the hadron experimental hall were introduced.

Tokushuku explained the project implementation plan (PIP) of KEK. For the three major ongoing research projects, J-PARC, SuperKEKB and the Photon Factory, the scope and priorities with the current funding sources are defined. For J-PARC, the highest priority should be placed on obtaining sufficient operation time, while the following projects are to be conducted as on-going upgrade projects; construction of COMET Phase-I, reinforcement of the facilities for T2K, the neutron polarization project at MLF, construction of the central portion of the MLF muon H-line and completion of the high-momentum beam line. The prioritization of "future" projects that require additional funding resources is as follows: 1. upgrade of J-PARC for the Hyper-K Project, 2. particle physics in HL-LHC/ATLAS, 3. construction of the MLF muon beam H-line and g-2/EDM experiment, and 4. extension of the J-PARC Hadron experimental facility. Tokushuku noted that the PIP review is a general guideline and that it is the J-PARC PAC's mandate to assess the scientific merit and technical feasibility of the prioritized J-PARC projects.

Tokushuku updated the mid-term plan of particle and nuclear physics programs in J-PARC that was shown at the July 2015 PAC meeting. The initial budget for the MR power supply upgrade was allocated starting from JFY2016, and the upgrade will be completed in summer 2018. In the current budgetary situation, the completion of COMET and the high-p beam lines will be delayed to the end of JFY2018. The MR-SX beam power will remain at the ~50 kW level until the hadron hall primary target is exchanged during the long shutdown in 2018. MR-SX operation will not be possible until March 2017 because of vacuum consolidation work of the Hadron experimental facility. The K1.1 beam line can be built and operated in March-July 2018 if the scientific program with the beam line is considered to be important and urgent; this would require an additional ~2M$ expenditure. Tokushuku asked the PAC to discuss two scenarios with different timings for the K1.1 beam-line implementation.

2-2 J-PARC Center Report (Naohito SAITO, J-PARC Center Director)

The J-PARC Director, Naohito Saito, welcomed the PAC members and presented an overview of the J-PARC facilities.

Saito showed prospects for improvement of the accelerator beam power and various science programs using the two MW-class proton synchrotrons at J-PARC, the RCS and the MR. The long-term goal for the MR FX beam power is 1.3 MW although the MR power supply upgrade was delayed by one year from the original schedule. Operation of the MLF neutron source has been resumed with 200 kW beam power after problems with the mercury target vessel in 2015. Reinforcement of the mercury target was shown as part of the plan for the improvement of the MLF beam power.

The future J-PARC projects evaluated in the KEK-PIP review, COMET-II, J-PARC upgrade for Hyper-Kamiokande, Hadron Hall Extension, and MLF Muon H-line and g-2/EDM, were explained. The J-PARC upgrade plan will be revised according to the outcome of the KEK-PIP review.

Saito explained the many efforts to improve the research environment at J-PARC: the MR power supply upgrade, KEK-PIP endorsement of J-PARC's ongoing major construction projects such as COMET phase-1, improvement of access to the J-PARC campus, enhancement of utilities in the main research building, and establishment of a tighter tie with local communities.

J-PARC efforts towards improving the budget situation were also explained. For JFY2016, an operation budget corresponding to nominal operation for 6.5 months was submitted and accepted. The budget for new MR power supplies and their buildings was approved. As a result user operation time in JFY2016 will be at the same level as in JFY2015. Saito mentioned also the possibility of obtaining a supplementary budget in JFY2016. For JFY2017 operation, the same level of funding was requested to the government from KEK. In any case, KEK/J-PARC internal efforts to maximize the beam operation time will be made.

The recent status of accelerator operation was shown. In JFY2015, the allocated beam times for the NU and HD experiments were 1,671 hours and 1,752 hours, respectively, while the actual available beam times (fractions) provided for the NU and HD experiments were 1,169 hours (70.0%) and 1,517 hours (86.6%). In JFY2016 so far, the allocated beam times for NU and HD experiments are 892 hours and 612 hours, respectively. The actual available beam times (fractions) up to the present time for the NU and HD experiments are 652 hours (73%) and 515 hours (84%), respectively. Saito presented the accelerator operation schedule until the end of March 2017. The budget to operate MR up to the end of JFY2016 is being sought.

Finally, Saito reported that J-PARC PAC recommendations provided in the last PAC meeting were explained to the J-PARC International Advisory Committee (IAC) to assist their evaluation of the global performance of J-PARC; Saito also explained the recommendations made by IAC to this PAC meeting. Saito concluded by showing the summary of the goals in the next 5 years for J-PARC and each experimental facility in the laboratory.

2-3 J-PARC Accelerator Status & Plan (Fujio NAITO, J-PARC/KEK ACCL)

Fujio Naito summarized the J-PARC accelerator status and plan. He presented the beam power history with a focus on 2016 operation. The accelerator team succeeded in operating the MR in FX mode with a beam power of 425kW and in SX mode with a beam power of 42 kW. There were two beam interruptions while attempting to reach FX beam power above 400 kW: one was caused by a short circuit in one of the bending magnets in the MR followed by collimator trouble (a vacuum leak) in the RCS while the other was caused by a short circuit of a transformer in the power-receiving station. All of these problems were fixed quickly although the loss of proton delivery time to the T2K experiment was not negligible. On the other hand, SX operation was relatively stable and the accelerator group succeeded in realizing a beam duty factor of 49% by applying the transverse RF efficiently. A high-power beam study was done to test extraction of a 50 kW beam in the SX mode. They succeeded in extracting a 50.8 kW beam with an extraction efficiency of 99.53% and a duty factor of 55.3%. A further attempt was made to operate the MR in SX mode with even higher beam power but without extraction. Studies will continue in order to achieve even higher beam power both in the FX and SX modes after the summer shutdown.

Naito then presented the mid-term plan for the MR beam power upgrade. The accelerator group plans to install new power supplies in 2018 along with a high gradient RF and injection/FX system upgrade. These improvements will allow the realization of 1.3 MW beam power with a repetition rate 1.16 sec. Finally, Naito showed the operation schedule for the second half of JFY 2016. LINAC operation will resume in October followed by RCS and MR conditioning. MR user operation is expected to start at the end of October in FX mode.

2-4 Hadron Hall Beam Status, and Target R&D Plan (Takeshi KOMATSUBARA, J-PARC/KEK IPNS)

Takeshi Komatsubara, the deputy head of Particle and Nuclear Physics division of J-PARC, explained the issues related to the Hadron Experimental Facility.

The downstream part of the K1.1BR beam-line and the area had been dismantled, and three beam-lines: K1.8, K1.8BR, and KL were in operation for physics data

taking from May 27 to the end of June 2016 with 42 kW beam power. The efficiency of beam usage for users was 79%. The slow-extraction duty factor was 36%, and the spill duty factor, which depends on the time structure of the extraction, reached 52%.
Construction of three new beam-lines named high-p, K1.1, and COMET in the south area of the Hadron Hall will provide new and wider opportunities for nuclear-hadron and particle physics. The southwest wall will be opened during this summer. The vacuum system for the middle and downstream parts of the primary beam-line will be consolidated from late September to January 2017. Thus, no beam is planned in the Hadron Hall before March.

The limitation to the current production target for the 50 kW beam, is the titanium-alloy beam window of the target chamber. Optimization of the design for the next indirectly water-cooled target system, for 80kW, and studies of problems that could possibly occur are in progress. Given the current budgetary situation, the target exchange will take place during the long shutdown of 2018, so that the maximum power will remain at the 50 kW level. R&D for a higher-power target, intended for the 150-200 kW range has already started.

2-5 FIFC report (Shoji UNO, KEK IPNS)

Shoji Uno presented a report from the Facilities Impact and Finance Committee (FIFC). The FIFC committee meeting was held on June 15th, 2016. At this meeting, three status reports (E62, E40, and E16) and the feasibility of the E63 experiment, which is requesting stage-2 approval, were discussed. The COMET group presented the status of construction of the new primary beam line (B line). Results of discussions and FIFC recommendations were reported at this PAC meeting and are summarized below.

E62: Safety issues for the X-ray tube and the target cell were discussed. The experimental group proposed to use the X-ray tube for energy calibration and explained a method to protect workers from being irradiated; the X-ray tube is covered with a stainless steel box to reduce the radiation dose to a low enough level. There is a metal plate equipped in a chamber connected to the X-ray tube by flanges inside the box. This plate converts the primary X-rays emitted from the tube to a secondary X-ray by which the calibration is carried out.

The FIFC recommends that the experimental group should verify the flange connection while using the X-ray tube. In addition, the FIFC requests that the radiation safety issues of the experiment including X-ray tube operation should be further reviewed by the 'radiation safety review committee of J-PARC.'

The E62 experimental group also reported that the target cell successfully passed an airtight examination at a pressure two times higher than the operation pressure at liquid nitrogen temperature. However this safety factor of two is not sufficient; the FIFC recommends that the experimental group should consider additional safety measures around the target cell in case of its rupture.

E40: Stage-2 approval of this experiment has already been issued by the IPNS director. All aspects raised in the previous FIFC were basically studied and described in the updated TDR. The FIFC encourages lowering the high voltage of the BGO calorimeter PMT by using an additional amplifier to have a better performance in a high counting rate environment. The FIFC recommends confirming that the thickness of the aerogel Cherenkov is optimal.

A pressure test of the liquid H_2 target cell at a cryogenic temperature was successfully carried out. The FIFC agrees to use the current design of the target. A remaining safety issue is to confirm that the equipment around the target is explosion proof. The experimental group should join the on-going discussion on this issue at the J-PARC center.

E16: The FIFC heard a status report on the E16 tracking system. It was pointed out that the tracking performance is still marginal even with smaller beam background by about a factor of three. The experimental group presented a design with a silicon strip detector as an additional innermost tracking layer. The performance with this configuration is better for the nominal beam background as expected. The FIFC strongly recommends further studying this design.

E21: Progress in the studies mainly on the beam line and experimental area was presented, with emphasis on comments made by the technical review committee. The FIFC finds that these studies are, in general, proceeding reasonably. However, the FIFC continues to review some aspects of the design of the experiment: primary proton beam monitors, provision for subsidence of the floor level, and the engineering design of the tungsten shield.

Several issues concerning the primary proton beam line were discussed at the meeting. The diamond detector that the experimental group is now proposing to use as a beam profile monitor and extinction monitor looks promising in terms of radiation hardness and fast response along with a good signal to noise ratio. The FIFC recommends conducting further studies in the realistic conditions of beam operation. The FIFC also stresses the importance of a safety review by the relevant J-PARC committee for its maintenance scheme of radioactive materials. FIFC confirms again the importance of demonstrating proton beam acceleration and extraction at 8 GeV. The experimental group presented studies on 3-bunch and 4-bunch operations of the MR. Both are found to be feasible although the experimental group prefers 4-bunch operation as this scheme was adopted for Phase-II. This is a reasonable decision, however, the FIFC finds further examination would be beneficial to the experiment.

E63: The E63 experiment conducts spectroscopic studies of the γ-ray from hypernuclei such as ${}_{\Lambda}^{4}H$ and ${}_{\Lambda}^{7}Li$ as a continuation of the E13 experiment, which was performed at the K1.8 beam line in 2015. The new E63 experiment is proposed at the K1.1 beam line, which is not fully equipped yet. Two presentations were made at the FIFC meeting related to E63: the design of the K1.1 beam line and the design of the experiment itself.

The design of the K1.1 beam line and the expected performance of its 1.1 GeV/c K beam for the E63 experiment were presented. The beam line is 28.13-meters long and is situated on the south floor of the Hadron Hall. The beam line flux is 200k K^- per spill. This is sufficient for E63 although lower than that at the K1.8 beam line provided for E13.

There will be a possible conflict between the K1.1 and high-p beam lines once both are constructed. Thus, a number of issues should be carefully considered and evaluated before starting the construction of the K1.1 beam line. In particular,

- the feasibility of building the K1.1 experimental area and its shielding as well as the beam dump,
- possible impacts of the operation of the K1.1 beam line and running E63 on the performance of the KL beam line and the KOTO experiment, and
- compatibility with experiments using the high-p beam line.

The FIFC is concerned about the frequent change-over between K1.1 and the high-p beam line, from the viewpoint of the approval of the operation license for the radiation by the government when changing the beam line configuration, and the non-negligible change-over cost. Note that requirements for the radiation shield of primary proton beam experiments are strict and may not be relaxed for secondary beam line experiments once the area is used for a primary proton beam experiment. Thus, the FIFC emphasizes the importance of careful planning and coordination of the K1.1 and high-p experiments.

The proposed E63 experiment was explained after the presentation of the beam line. All necessary detectors including the Hyperball-J detector and the experimental setup are basically the same as in the previous E13 experiment with minor modifications, such as aerogel radiators with a slightly higher index of refraction to match the lower particle momentum. Therefore, the FIFC does not find any difficulties in their detectors. The proposed target material, ^{7}Li and Li_2O, that will be used are packed in a laminated aluminum film. The FIFC finds that this is safe enough for conducting the proposed experiment.

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

E11 (T2K)

T2K (E11) presented a status report including both operations and physics achievements. In the past year the PAC approved T2K for $6\text{x}10^{20}$ POT but because of accelerator problems they were only able to record $4\text{x}10^{20}$ POT. In spite of having only collected 20% of the originally approved protons on target exposure,

T2K has made the most precise measurements of muon neutrino and antineutrino disappearance and has made leading measurements of electron neutrino and antineutrino appearance. These results were recognized by the international neutrino community at the Neutrino 2016 conference in London this year. However, they pointed out in this PAC presentation that NOvA after 2 years of running is starting to be competitive to T2K with its neutrino running results.
Because of its leading role in statistical precision, T2K has also led the neutrino community in evaluation of systematic uncertainties. Progress on their cross section program was also reported, including the first measurement of quasielastic-like events on the water target in neutrino mode. The collaboration appears to be going strong with continued plans for updating analyses with more statistics and new analysis techniques.

The PAC is pleased to see the good progress of the T2K experiment and its impact on the world's knowledge of neutrino physics. The collaboration has requested 9×10^{20} POT before the summer 2017 shutdown. The PAC recommends that IPNS should make best arrangement to provide T2K with additional beam delivery as much as possible to keep the experiment competitive.

P65 : Proposal for Extended T2K Run

T2K requested an extended exposure of protons on target, in total 20×10^{21} POT over 10 years, which would allow the possibility of a 3-sigma sensitivity for CP violation for the case where the mass hierarchy is known and CP violation is maximal (CP phase $\delta = -\pi/2$) using the current reactor measurement's central value of θ_{13}. In order to achieve this goal by 2026 when long-baseline experiments (e.g., Hyper-Kamiokande and DUNE) of the next generation start taking data, accelerator upgrades must take place. These include improving the proton beam power from the current ~450 kW to 750 kW, and then to 1.3 MW. Funding has already been identified to improve the beam power to reach 750 kW. Neutrino beam line upgrades are also required to allow operations at higher power. Changes in the analysis techniques to allow for a larger fiducial mass to be used and for more neutrino interaction channels were also presented, which would increase the statistics per POT by 10% and 35%, respectively. Finally, plans for systematic uncertainty reduction from the current 6% to 4% were discussed.

The SK collaboration has decided to add gadolinium (Gd) to the water to improve neutron detection efficiency and increase sensitivity to low energy neutrino physics (relic supernovae neutrinos, for example), but the impact on the T2K program has not been fully evaluated.

The PAC endorses the physics program to attempt to establish evidence of non-zero CP violation in the lepton sector outlined by this proposal and recommends stage-1 status. To both complete the current T2K program and meet T2K-II goals significant upgrades of the J-PARC accelerator complex must be completed and done so in a timely manner. Before this proposal is to receive stage-2 approval detailed technical reviews should be held to examine the beam line upgrades necessary to achieve 1.3 MW operation and near detector upgrades. The PAC would like to see a demonstration of the proposed analysis improvements, in order to understand better how the systematic uncertainties change in the new higher acceptance analysis.

P61 (NuPRISM)

NuPRISM provided a status report and update of their proposal. The concept of the phase-0 detector on the surface at 280 m from the target was presented as part of the R&D program for NuPRISM. The PAC recommends stage-1 status for NuPRISM. The scientific merit of the proposal is well motivated now as the PAC has recommended stage-1 status for T2K-II (P65). The statistical reach of T2K-II motivates the improved systematic uncertainties that NuPRISM can offer. In addition, NuPRISM offers potential for further understanding of systematics for SK and SK-Gd and other future long baseline programs as well as potential for a search for sterile neutrinos.

E56 (Sterile Neutrino Search)

The biggest news from the E56 (JSNS2) experiment, a search for sterile neutrino using decay-at-rest antimuon neutrinos at MLF, is that they obtained grant-in-aid funding to build one of the two planned detectors and can start data taking in JFY 2018-19. The PAC is pleased to learn this - further efforts to increase the sensitivity to make the experiment more competitive are encouraged.

They have started negotiations with J-PARC and MLF management about possible detector locations on the maintenance floor above the mercury target for neutron production. The PAC encourages the group to continue further discussions on safety matters as well as finding the optimum detector location in view of physics sensitivity, within the boundary conditions resulting from the safety requirements.

R&D is ongoing on liquid scintillator capable of gamma/neutron discrimination. They found that a LAB (Linear alkylbenzene)-based liquid scintillator with 0.5g/L PPO ($C_{15}H_{11}NO$) concentration can have both Cherenkov and scintillation light emission and pulse-shape discrimination power at the tail timing. Random noise will not affect the performance of the pulse-shape discrimination although the effect of coherent noise should be further studied.

Another in-situ background measurement was done from May to June 2016 using a 1.6L LS sample in order to better understand the background. Data analysis is in progress.

The PAC strongly recommends that the group continue serious evaluation of experimental sensitivity by using a full Monte Carlo simulation and the results of in-situ background measurements to finalize the TDR and advance towards stage-2 approval.

E14 (KOTO)

KOTO plans to present results from run 62 in 2015 at the Kaon2016 conference with a sensitivity about two times better than the 2013 run and a factor of 6 away from the Grossman-Nir bound (1.5×10^{-9} from the $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ measurement with isospin symmetry). They also plan to publish results from a very short run in 2013 with a sensitivity comparable to E391a.

The result of the analysis of the remaining data from 2015 (runs 63-65) has not yet been shown. Since the rates increased substantially by the end of that run (42 kW vs 24 kW) the analysis of this data is critical to understand backgrounds and sensitivity. The PAC members strongly recommend analyzing the existing data including 2016 data (run 69 with the inner barrel installed) in a timely manner in order to demonstrate the efficacy of the background suppression at the next PAC.

Studies of neutron-gamma interactions in the calorimeter have improved the neutron-gamma separation power from 1,000 to 10,000. However, they observed two events in the run-62 background area where only negligible background was expected. This may indicate a lack of understanding of background and imply that they may observe significant background in the signal region. This should be fully understood before opening the signal box.

The projected background of 2.2 events for the full 2015 run was shown, but the number should be updated with the new neutron rejection cuts applied to all the background sources. The projected sensitivity is somewhat below the Grossman-Nir bound, and the expected upper limit is smaller than the existing limit.

But as mentioned in the previous paragraph, there seems to be rather large contribution from unknown background sources. In order to get the reliable expectation of the limit from 2015 data, understanding and the estimated of the size of this unknown source is necessary.

In 2017 three months of running is requested to achieve a sensitivity comparable to that of 2015. With this new data, they should achieve a sensitivity close to or better than the Grossman-Nir bound. The PAC believes that it is important to assess the background in the 2015 and 2016 data before starting the 2017 run. KOTO plans to add SiPMs on the front of each CsI crystal to improve neutron-gamma separation by another factor of 10 in 2018.

E36 (Lepton Universality)

E36 has completed data taking and is now preparing for a lepton universality test. The experiment was disassembled in January 2016. Due to the relatively short data taking period, the expected sensitivity on the lepton universality ratio is 0.5% rather than 0.3% as originally planned.

Initial examination of the data does not show the expected PID performance (i.e. μ-e separation) as was already shown at the previous PAC. For one of the PID systems there has not been rapid progress; the TOF time-walk corrections have not been applied. There has been more progress on the tracking: 4-point tracking using three stations of MWPCs and the target is working. Significantly better tracking using 5-point tracking including the scintillator fiber tracker is expected. Clear $K\mu 2$ and $K\pi 2$ signals were shown. However, the $Ke2$ signal from a small data subsample has poor mass resolution, which should be improved with 5-point tracking and better pattern recognition. Measurements of the ratio $K\mu 2/K\pi 2$ versus B field have been also carried out; this allows determination of the acceptance with high precision and low systematic uncertainty.

E36 expects to complete their systematic studies by summer 2017. However, we hope for more rapid progress and regular updates on the progress of the analysis at the upcoming J-PARC PAC meetings.

There is also world-wide interest in dark photon searches including on-going dedicated experiments at JLAB and Mainz as well as searches by collider experiments (e.g. at KLOE, BaBar and Belle). Progress in this area was not presented and should be shown at the next PAC meeting.

E34 (g-2/EDM)

E34 is an experiment to measure the anomalous magnetic moment of the muon (g-2) using innovative muon cooling techniques. The physics goal is a measurement with 0.1 ppm statistical error and 0.1 ppm systematic error. The experiment will use a surface muon beam to produce muonium, which is ionized and accelerated to 300 MeV/c in a LINAC, and then injected into a solenoid magnet instrumented with silicon strip detectors where the electrons from the decays are measured.

The design of the low-beta accelerator component has been published in Phys. Rev. Accelerator and Beams. Low energy injection without an inflector has been published in NIM and tests are planned. Beam profile monitors and magnetic field mapping studies have been accomplished. Beam studies of laser ablated aerogel at TRIUMF are planned. Silicon strip detectors and front-end ASICs have been manufactured. An important issue to resolve is the flux of produced muons for which significant fraction is still missing for the final goal.

The experiment is starting to test predictions for the expected statistical precision and has preliminary limits for the expected systematic uncertainties. These predictions should be refined in time for a dedicated, focused review of the technical design. The PAC expects the E34 group to complete the TDR before this review in this fall.

E63 (Gamma-ray Spectroscopy of Light Hypernuclei)

The E63 experiment aims to study the excited state spectrum in ${}^4_\Lambda$H and ${}^7_\Lambda$Li hypernuclei with a high precision γ-ray spectroscopy technique. It will make use of the Hyperball-J germanium array mounted at the SKS spectrometer. The experiment will be installed at the future K1.1 beam-line of the Hadron Hall. The measurement of the ${}^4_\Lambda$H($1^+ \rightarrow 0^+$) transition will allow the experiment to unambiguously establish the spin dependence of the charge symmetry breaking in the mass 4 hypernuclear system. The measurement of the ${}^7_\Lambda$Li($3/2^+ \rightarrow 1/2^+$) lifetime aims at the determination of the corresponding B(M1) value, which can be expressed as an 'effective g-factor' of the Λ particle bound inside a nucleus. The physics behind both measurements is intimately related to the ΛN – ΣN coupling and the role of three baryon forces in hypernuclei. In view of significant progress in ab-initio nuclear structure calculations, the proposed measurements are in the forefront of today's hypernuclear physics studies.

The spectrometer system and almost all detectors have been used previously by the E13 collaboration. The measurement of the $^{7}_{\Lambda}$Li($3/2^{+} \rightarrow 1/2^{+}$) lifetime requires a dense lithium target to provide a proper stopping time for the produced hypernuclei. Instead of lightweight elemental lithium, the group intends to make use of a Li_2O crystal. The committee was pleased to see the detailed R&D work characterizing such a target. Monte Carlo calculations indicate that the attempted accuracy of the lifetime measurement can be achieved. Funding for the experiment is secured and the measurement could be performed shortly after the installation of the K1.1 beam line. In total, the collaboration aims at 60 days of running. This period should be split in two blocks separated by about 2 months to enable the maintenance of the germanium detectors.

By the very successful completion of the E13 experiment, the Collaboration has demonstrated their expertise, which is needed to accomplish the experimental program. The PAC agrees that both proposed measurements are very important and timely and recommends stage-2 approval for the E63 experiment.

E50 (Charmed Baryon)

E50 presented an update of their plans. E50 will use a high intensity 20 GeV pion beam produced by an initial 30 GeV proton beam.

To carry out measurements of charmed baryons using the recoil mass technique with D(*) tagging a fairly complex spectrometer is required compared to an experiment that only measures strange baryons. The detector, which must handle high rates, is still in the very early R&D stage. Recently E50 has received some Grant-in-aid funding for R&D on high-speed detector DAQ. This R&D work will benefit the entire high-p beam line community and has synergies with LEPS-II at SPring-8.

E50 will not be competitive in statistics of charm baryons with Belle, Belle II or LHCb. However, E50 can measure the production mechanisms. Furthermore, using the missing mass technique does not require full reconstruction of individual charm baryon decay modes.

E50 has initiated some collaboration with theorists as suggested by the previous PACs. One Phys. Rev. D paper was published in 2015 with Kim, Kim, and Hosaka. Another article is in preparation with Nagahiro, Yasui, Hosaka as well as a collaboration with Japanese LQCD experts.

E50 is investigating the feasibility of charm pentaquark searches. This would require muon detection and lowering the beam energy to 10 GeV.

As suggested at the last PAC meeting and the FIFC, IPNS should investigate the feasibility of the high-p secondary beam line for E50.

E31 (Hyperon Resonances below KN Threshold)

Progress on the analysis of $\pi\Sigma$ missing mass spectra deduced from d(K^-,n)$\pi\Sigma$ with neutrons detected in forward direction was reported. Following a 2.2 days pre-run in May 2015, the experiment took 7 days of data in May/June 2016. The original aim had been to explore the $\Lambda(1405)$ and $\bar{K}$N threshold regions in view of theoretical approaches based on the chiral SU(3) symmetry breaking pattern of low-energy QCD. An accurate determination of $\pi\Sigma$ spectra in all three charge configurations ($\pi^+\Sigma^-$, $\pi^-\Sigma^+$ and $\pi^0\Sigma^0$) is expected to contribute important information to the understanding of basic coupled-channels dynamics in the low-energy region around $\bar{K}$N threshold.

While the $\Lambda(1405)$ (or rather: the pole predicted around 1420 MeV by chiral SU(3) coupled-channels dynamics) is not evident in the data, a pronounced maximum in the summed $\pi\Sigma$ spectrum above $\bar{K}$N threshold around 1450 MeV was observed and reported in the previous PAC meeting.

The E31 collaboration has now focused on the detailed separation of the $\pi^-\Sigma^+$ and $\pi^+\Sigma^-$ channels. The preliminary results presented at the meeting are promising. Further efforts have been made to analyze the $\pi^0\Sigma^0$ final state (though with low statistics) and the $d(K^-,p)\pi^-\Sigma^0$ mode in order to gain complete isospin I = 0 and I = 1 information.

In the meantime, dedicated three-body Faddeev calculations of $d(K^-,n)\pi\Sigma$ reactions have been published, using coupled-channels amplitudes based on SU(3) effective field theory. The E31 collaboration is strongly advised to conduct further detailed analysis in close contact with these theoretical developments as they may provide an understanding, in terms of underlying three-body dynamics, of the structures seen in the different $\pi\Sigma$ channels.

The PAC supports the efforts to further increase the data statistics. However, the collaboration should justify their beam time request (18 days at 45 kW) by providing simulations for each of the $\pi^+\Sigma^-$, $\pi^-\Sigma^+$ and $\pi^0\Sigma^0$ channels and for the π-Σ^0 (I=1) mode, pointing out quantitative figures of merit for the improvement of statistics in each channel. Background-subtracted and efficiency-corrected distributions should be presented for proper comparison with theoretical models.

E62 (Precision Spectroscopy of Kaonic Atom X-ray with TES)

The E62 experiment aims to observe X-rays from the kaonic ^{4}He and ^{3}He atoms emitted in the transition from the 3d to the 2p orbitals. The energy shift and the width of these transitions are essential to resolve the long-standing problem concerning the depth of the K^- nucleus potential. Since the width of the transition is predicted to be as small as about 2eV, a high energy-resolution measurement technique based on a superconducting transition-edge-sensor (TES) was introduced.

The previous PAC supported the joint request of E62 and E57 to perform a commissioning run to optimize their beam line and target configuration. These measurements were performed in K1.8BR line and showed good control and understanding of K^- stopping in a Li target. A test of the TES has also been performed and energy resolutions of 5.0 eV (6.7 eV) have been achieved under beam-off (beam-on) conditions.

The beam time allocation has been requested after March 2017, which includes four days for full commissioning and 16 days for the production run. Note that the experimental group now thinks it is better to perform the measurement with the ^{3}He and ^{4}He targets separately instead of measuring simultaneously using a mixed target as originally planned. It is not necessary to extend the beam time to realize the separate measurements.

The PAC recommends the requested beam time be allocated when the K1.8BR beam line becomes available after completion of the ongoing experiment.

E57 (Strong Interaction Induced Shift and Width of Kaonic Deuterium)

E57 intends to make a first measurement of X-rays from K^--deuteron atoms, which would provide vital information on the K^-N interaction at threshold. The previous PAC supported the joint request of E62 and E57 to perform a commissioning run to optimize their beam line and target configuration. These measurements were performed in the K1.8BR line and showed good control and understanding of the K^- stopping in a Li target. A detailed simulation of a planned kaonic hydrogen test run gives an expected sensitivity and energy resolution at least comparable to or better than the previous SIDDHARTA (Frascati) data that define the present state-of-the-art.

E57 demonstrated that their Silicon Drift Detectors (SDD's) provided an in-situ line-width of 200 eV (FWHM) at -40 ℃ with a ^{55}Fe source, with a shift of less than 6 eV between beam-on and beam-off conditions. Measurement of the K^--Li L_a X-ray agreed superbly in absolute energy with a QED-only calculation. Good progress was also reported on the development of a prototype cryogenic (30 K) gas target cell designed to operate at 0.3 MPa. All work appears to be on track for a requested beam test consisting of 3 days beam tuning plus 3 days running with a gaseous H_2 target. The PAC endorses this request, and encourages the collaboration to work with the FIFC in advance of a scheduled safety review in December 2016 to maintain progress towards this goal. Successful completion of this proof-ofprinciple test measurement would provide strong impetus towards stage-2 approval.

E40 (Measurement of the Cross Section of Σp Scatterings)

E40 will measure Σp scattering in the K1.8 beam line with a modified version of the KURAMA spectrometer together with the CATCH detector. Sigma production is realized by the (π, K) reaction. The data will lead to better understanding of the flavor dependence of baryon-baryon interactions, and are relevant to hypernuclear physics and the internal structure of neutron stars. The data would also be compared with ongoing lattice QCD simulations of the baryon-baryon interactions with the physical pion mass.

The PAC is pleased to see various developments with the hydrogen target, trigger estimation, etc. which are reflected in the updates of the TDR. We encourage the collaboration to proceed with further preparations.

The Cylindrical Fiber Tracker (CFT) construction is complete. The group has developed a new shaping amplifier and low-voltage operation of the PMT's in the BGO detector that will provide stable behavior at high intensities. CATCH, the combination of the CFT with the BGO array, is scheduled for completion early this fall, to be followed by test measurements in pp and pd scattering at CYRIC in November. The Aerogel Cherenkov (AC) counter development is on track. The LH_2 target is under construction.

E40 requires 5 hours of beam-size measurements to optimize the DC mask and the configuration of the beam hole in their AC detector. They requested these beam size measurements at the end of the E07 experimental cycle in late spring. They have also requested that radiation level studies by the HD hall staff be made during beam tuning. With these developments they expect to be ready for data taking in November 2017.

E05 (Spectroscopic Study of Ξ-Hypernucleus)

E05 will perform a spectroscopic study of Ξ-hypernucleus formation using the ^{12}C(K^{-}, K^{+}) double-strangeness and double-charge exchange reaction. Further progress in the data analysis of the E05 pilot run has been reported, now with a focus on the sub-threshold region in which the Ξ is potentially bound to the ^{11}B core. The data were taken with the SKS spectrometer (the E13 setup) when it was positioned in the K1.8 beam area. An energy resolution of 5 MeV was obtained, roughly a factor of three superior to that of the previous BNL experiment (E885). The final goal is to study Ξ-hypernuclear spectra by measuring the ^{12}C(K^{-}, K^{+}) reaction with a resolution of about 1.5 MeV at the S-2S spectrometer that is being prepared.

The E05 pilot run took two weeks of beam time in November 2015, providing 6000 Ξ's per day; 80k quasi-free ^{12}C(K^{-}, K^{+}) events were analyzed and reported at the last PAC meeting. Further background reduction was performed in the meantime, resulting in a flat background with only 1.08 counts per bin. A limited but significant number of events were found in the bound-Ξ-hypernucleus region, from threshold down to a binding energy scale of about 20MeV. This indicates stronger binding than what was extracted from BNL E885. A translation of this result into the corresponding attractive Ξ-nuclear optical potential is under way. An important physics issue to be addressed is the determination of the Ξ-N coupling to ΛΛ and the corresponding conversion width.

With the successful completion of this pilot run, the PAC now looks forward to receiving a new proposal based on the upcoming S-2S spectrometer in combination with higher beam current. This proposal should include a detailed evaluation of the increased number of events to be expected in the Ξ-hypernuclear bound-state region, given the improved conditions that are expected.

E07 (Double Strangeness System with a Hybrid Method)

The objective of E07 is to search for double hypernuclei with a hybrid-emulsion method. The goal is to reach more than ten times the statistics of the previous KEK experiment (E373) and to make a mini-chart of double hypernuclei. Following the commissioning of the setup at the KURAMA spectrometer, a first 5-day physics run was performed in June 2016. About 15% of the existing emulsion stacks could be exposed during that period. They reported the present status of the ongoing work in the photographic development of these emulsion plates. They discussed the problem caused by Compton electrons from natural backgrounds and presented an effective method to erase these background traces by a treatment with humid air. The committee congratulates the E07 group for the successful completion of this first physics run and looks forward to seeing the first reconstructed hypernuclear events.

E07 also presented a few improvements, which help to optimize the exposure process in the future. E07 requests 31 days of beam to expose the remaining 100 emulsion stacks. In addition, two days for commissioning and optimizing of the improved setup are required. The PAC understands the importance of emulsion exposure to a K-beam in a timely manner to avoid irreversible deterioration of the emulsion stored at the Kamioka mine. In order to reach the initial goal of significantly improved statistics compared to the KEK-E373 experiment, the PAC supports additional beam time for E07. The PAC requests a detailed quantitative evaluation of the necessary beam time to reach this goal including further efficient beam use and contingency as well.

E03 (Measurement of X-ray from Ξ-atom)

The E03 proposal aims at observing for the first time the X-rays from a Ξ^{-}Fe atom to obtain the optical potential between the Ξ^- and nuclei. Since the orbit of Ξ^- is strongly affected by the nucleus, in particular, when the Ξ^- is orbiting just around the nucleus before being absorbed by the nucleus, the X-rays emitted in the transition of Ξ^- contains information on the interaction between the Ξ^- and the nucleus. The energy shift of the X-rays is relevant to the real part of the optical potential while the width gives information on the imaginary part.

The experiment is being planned at the K1.8 beam line. The Ξ^- particle produced by the (K^-, K^+) reaction on the Fe target will stop in the target forming a Ξ^- atom. The X-rays emitted from the Ξ^- atom will be measured by a Ge detector array in coincidence with the identification of K^+ by the large acceptance KURAMA spectrometer.

The current status of the experimental apparatus and the plan for the experiment were reported. The KURAMA setup including the K1.8 beam line is common with the E07 and has confirmed to work well in the previous E07 experiment. It has been proposed to use the Clover-shape Ge detector array for the X-ray measurement instead of the Hyperball-J array originally planned in the proposal in order to take advantage of the better energy resolution of the Clover-shape array. Another advantage of using the Clover-shape array is that the target can be placed closer to the KURAMA spectrometer resulting in the increase of the KUKRAMA spectrometer acceptance, which compensates for the lower efficiency of the Clover-shape array.

For the experiment, a two-stage strategy is proposed. The first stage is to observe the X-rays emitted in the transition from the orbit with principal quantum number n=7, while the second stage is to observe the X-rays from the orbit with n=6. The former is easier to detect because of its relatively high yield, while the energy shift and the width is not expected to be significant. On the other hand, the latter could have a larger energy shift and width even with much less intensity. The experimental setup in the second stage will be optimized based on the experience acquired during the first stage so that the goal of the experiment could be accomplished in the second stage.

The PAC appreciates the updated plan of the experiment including the use of the Clover-shape array and the two-step approach.

E21 (COMET)

Following the focused review of the TDR at KEK, COMET provided an updated TDR on July 22, 2016 for the J-PARC PAC.

The COMET team addressed the major items that were raised during the last focused review on June 30th and responded to the 16 recommendations of that review. COMET made a large number of significant additions to the TDR. They presented initial plans for a cosmic ray run in 2018, an engineering run and a pilot physics run as proposed by the last PAC and the last focused review.

The J-PARC PAC now recommends that COMET be granted stage-2 approval. Tests of main ring operation at 8 GeV should be carried out soon. The request is two periods of 8 GeV running for a total of 8 days.

There are still a number of items in the COMET TDR that should be improved. The progress of COMET should be closely monitored by KEK.

We list some of the remaining issues in the TDR.

1) The cosmic-ray run schedule does not include integration of the detector. The schedule should be more realistic and include dependencies between different subsystems.

2) The engineering run should be worked out in greater detail.

3) The plan for operating the StrECal at high intensities has not been worked out. The collaboration should clarify whether StrEcal uses dummy modules or a hole in the center of the system.

4) Various items in the TDR that were not completed in time for the July 22nd update should be completed. The final document should be carefully edited and posted on the ArXiv.

E16 (Measurement of Spectral Change of Vector Mesons in Nuclei)

E16 is an experiment with the goal of studying modification of spectral functions of vector mesons (ρ,ω and ϕ) in the nuclear medium. Vector mesons are produced in p-A collisions and detected by their decays into electron-positron pairs. It is similar to the KEK-E325 experiment but plans to have 100 times higher statistics.

The group decided to improve their tracker system (currently three GEM layers) by adding a fourth innermost SSD-based layer. Six SSD modules for initial operation will be provided by K. Tanida et al. In the future the high-p collaboration will produce SSDs to also be used in E50.

A realistic simulation of the experiment was performed including random hits and combinatorial background to estimate the expected yields of vector mesons. The group proposes a staged deployment scenario: Phase 0 (40 shifts) for detector/beam commissioning and cross section measurement in January or March 2019 and Phase 1 (160 shifts) for a production run in the fall of 2019 with a limited detector setup using modules that will be available, followed later by Phase 2 (320 shifts) after the full setup is realized. The group requested stage-2 approval for Phases 0 and 1.

The Phase-0 run should clarify various issues, which include beam halo conditions, magnetic field mapping and alignment of the detector, electron/pion separation, trigger conditions, methods of analysis at high rates, better estimation of the cross sections of vector meson production etc.

The PAC notes the importance of properly taking into account radiation effects, physical backgrounds due to Dalitz decays of vector mesons, as well as the possible interest in extending such studies to decays into muon pairs. The PAC also encourages the group to further communicate with theorists about the latest theoretical results of the in-medium spectral functions to make realistic comparison with the expected Phase-1 data with a limited number of detector components and the Phase-2 data with full detector components.

The group is strongly encouraged to submit an updated TDR including various plots based on a realistic simulation of the experiment with four-layer trackers so that the PAC may consider stage-2 approval at its next meeting.

4. BEAM TIME ALLOCATION FOR FY2016

Considering the severe international competition in long baseline neutrino research, the PAC agrees that T2K data accumulation should be competitive with the NOvA experiment and recommends allocating the maximum possible beam time to T2K.

The PAC also congratulates J-PARC for its excellent recent achievements and notes the promising new results from the experiments at the Hadron Facility; the PAC understands that good beam delivery is essential to maintain the productivity of the laboratory.

Following the report from the FIFC, the PAC recognizes the importance of beam studies of the MR at 8 GeV for the COMET experiment at the earliest convenience and suggests IPNS/J-PARC carry out two sets of high priority 4-day long beam studies.

Although it is not possible to fit all requests in the period, the PAC considers that a turn-over from FX to SX extraction on April 1st is the best compromise option, with the 8 GeV MR beam studies in slots both before and after April 1st. The PAC recommends allocating beam time in March 2017 for T2K. T2K will start data acquisition after the summer shutdown in 2016. Preparatory work for the K1.1 beam line can be scheduled in parallel. This will also benefit early construction of the K1.1 beam line, enabling E63 to perform its measurements in a timely manner. The PAC leaves it up to the facility group to make necessary fine adjustments for a reasonable and optimized operation. The PAC heard the proposed beam time arrangement would allow T2K to accumulate an additional 7.3×10^{20} POT assuming the best estimates of the beam power profile and a realistic level of availability.

The PAC considered the following experiments at Hadron Facility for the coming beam time allocation: E07, E03 phase-1, E31, E62, the E57 pilot run and the E40 beam survey. On-going experiments at K1.8 and K1.8BR (E07 and E31) will complete their measurements first. The length of their beam time allocations should be further optimized. The PAC sets priorities among the remaining experiments in the following order: E62, the E40 beam survey, the E57 pilot run and E03 phase-1. Some of the experiments might not be assigned beam time in this period depending on the optimization of the beam requests from the various experiments.

5. DATES FOR THE NEXT J-PARC PAC MEETING

The next J-PARC PAC meeting will be held on January 11-13, 2017.

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

- Minutes of the 21st J-PARC PAC meeting held on 13-15 January, 2016 (KEK/J-PARC-PAC 2016-11)
- Proposals
    - Update of the P61 Proposal (KEK/J-PARC-PAC 2016-17)
    - Proposal for an Extended Run of T2K to 20×10^{21} POT (KEK/J-PARC-PAC 2016-20)
- Technical Design Reports
    - Update of the E21 TDR (KEK/J-PARC-PAC 2016-12)
    - TDR for J-PARC E63 experiment "Gamma-ray Spectroscopy of Light Lambda Hypernuclei II" (KEK/J-PARC-PAC 2016-13)

- TDR from E40 (KEK/J-PARC-PAC 2016-15)

- Status Reports
  - E56 Status Report (KEK/J-PARC-PAC 2016-21)

- Letter of Intent
  - Letter of Intent for the J-PARC Heavy-Ion Program (KEK/J-PARC-PAC 2016-16)
  - Search for tetraneutron by pion double charge exchange reaction on ^{4}He (KEK/J-PARC-PAC 2016-18)
  - Investigation of Pion Double Charge Exchange Reaction with S-2S Spectrometer (KEK/J-PARC-PAC 2016-19)

- Safety Report
  - E62 Report on Safety Measures (KEK/J-PARC-PAC 2016-14)