KEK/J-PARC-PAC 2020-04
April 29, 2020

J-PARC Program Advisory Committee
for the Nuclear and Particle Physics Experiments
at the J-PARC Main Ring

Minutes of the 29th meeting held
16(Thu.)-18(Sat.) January 2020

OPEN SESSION:

1. Welcome and J-PARC Center Report: N. Saito (J-PARC/KEK)
2. J-PARC Accelerator Status & Plan: F. Naito (J-PARC/KEK)
3. Mandate to the committee K. Tokushuku (KEK)
4. Hadron Facility Status and Plan: H. Takahashi (J-PARC/KEK)
5. E40 (Measurement of the Cross Sections of Σp Scattering): K. Miwa (Tohoku)
6. E03 (Measurement of X-ray from Ξ^- Atom): T.Yamamoto (JAEA)
7. E42 (H dibaryon): J.K. Ahn (Korea)
8. E31 (Spectroscopic Study of Hyperon Resonances below KN Threshold): H. Noumi (RCNP-Osaka/KEK)
9. P73, P77 ($\Lambda 3H$ and $\Lambda 4H$ Mesonic Weak Decay Lifetime Measurement with $^{3,4}He(K^-,\pi^0)\Lambda 3,4H$ Reaction): Y. Ma (RIKEN)
10. E16 (Measurement of Spectral Change of Vector Mesons in Nuclei): S. Yokkaichi (RIKEN)
11. E70 (Spectroscopic Study of Ξ-hypernucleus, $\Xi 12Be$ via the $^{12}C(K^-, K^+)$ Reaction): T. Nagae (Kyoto)
12. P75 (Measurement of the Formation Cross Section of $\Xi - 7H$ in the 7Li(K-, K+) Reaction: H. Fujioka (Tokyo Inst. of Tech.)

13. E63 (Gamma-ray Spectroscopy of Light Hypernuclei: H. Tamura (Tohoku)
14. K1.8/K1.8BR Request Summary & K1.8 Floor Plan (mid-term): M. Ukai (J-PARC/KEK)
15. Hadron Hall Extension - Future Plan and HEF: T. Takahashi (J-PARC/KEK)
16. Hadron Hall Extension - HIHR: H. Noumi (RCNP-Osaka/KEK)
17. T2K(E11) Status and Plan 1 (J-PARC): T. Kikawa (Kyoto)
18. T2K(E11) Status and Plan 2 (SK): H. Sekiya (ICRR-Tokyo)
19. T2K(E11)/T2K-II(E65) Prospect: F. Sanchez (Geneva)
20. Hyper-Kamiokande Status: T. Kobayashi (J-PARC/KEK)
21. E56 (Sterile Neutrino Search): T. Maruyama (J-PARC/KEK)
22. E71 (NINJA): T. Fukuda (Nagoya)
23. E14 (KOTO): T. Nomura (J-PARC/KEK)
24. E36 (Lepton Universality): S. Shimizu (Osaka)
25. E21(COMET): Y. Kuno (Osaka)
26. E34(g-2/EDM): T. Mibe (J-PARC/KEK)
27. P76 (Searches for the Breaking of the Time Reversal Invariance in Polarized Epithermal Neutron Optics): H. Shimizu (Nagoya)
28. Beam Time Schedule in 2018-2021 T. Kobayashi (J-PARC/KEK)

CLOSED SESSION:

Present: I. Adachi(KEK), N. Aoi (RCNP-Osaka), M. Blanke (KIT), D. Harris (FNAL), Y. Itow (Nagoya), F. Le Diberder (CNS/IP2N3/LAL), A. Ohnishi (YITP-Kyoto), S. Kettell (BNL), R. Kitano (KEK), M. Kuze (Tokyo Inst. of Tech.), J. Pochodzalla (Mainz), H. Tamura (Tohoku), A. W. Thomas (Adelaide), K. B. Luk (Berkeley), N. Xu (LBNL), R. Yoshida (Chair, Argonne), K. Tokushuku (KEK-IPNS Director), T. Kobayashi (KEK-IPNS Deputy Director) and N. Saito (J-PARC Director)

1. PROCEDURAL REPORT

The minutes of the 28th J-PARC-PAC meeting (KEK/J-PARC-PAC 2019-16) were approved.

2. LABORATORY REPORT

2-1 Welcome and J-PARC Center Report (Naohito SAITO, J-PARC Center Director)

The J-PARC Director, Naohito Saito, welcomed the PAC members. He first introduced an overview of J-PARC facilities as well as science at J-PARC. He showed the operation status of J-PARC and stated that the operation of Main Ring (MR) with the fast extraction (FX) mode has been established at over 500kW. The user operation with such beam power is the first time ever while only a trial operation had been performed so far. He also mentioned that a new hadron-production target was successfully installed at the hadron experimental facility. The cooling capability of the previous target limited the operational beam power for slow extraction (SX). The new target enables them to operate above the beam power of 80kW. A new beamline, called B-line, for primary proton beam transport is also ready for next hadron facility operation. He also pointed out that J-PARC is improving its operation efficiencies and the power.

Saito presented the status of Material and Life Science Facility (MLF). He explained that the 1MW power operation is now getting close after a series of trial operation with increasing continuous operation time. There are several particle physics projects at MLF, sterile neutrino search JSNS2 (E56), precise measurement of muon g-2/EDM (E34) and fundamental neutron physics, e.g. measurements of its lifetime and EDM. Saito explained recent actions at J-PARC/KEK. He stated that the J-PARC upgrade for Hyper-Kamiokande (Hyper-K) has been the highest priority in the KEK Project Implementation Plan (KEK-PIP) and finally approved by the Government. He also said that KEK and J-PARC have submitted a J-PARC operation and upgrade plan to the Japanese Science Council Master Plan 2020, which included the realization of 1.3MW at MR for FX, muon g-2/EDM experiment, Hadron Hall extension, and COMET-phase2 together with 9 cycle operation of the MR. The MEXT Roadmap 2020, which defines large-scale projects in Japan, will be based on the Master Plan 2020 which is under discussion at the Japan Science Council.

Saito presented a plan of MR operation in the coming years. He explained that the decision of completing the upgrade of the MR power supplies in JFY 2021 is still unchanged. He mentioned that there will be no beam in JFY2021 because of the installation of the new MR power supply.

Saito summarized his talk after introducing the recent growing collaborations with academia and industry in the world.

2-2 J-PARC Accelerator Status (Fujio NAITO, J-PARC/KEK)

Fujio Naito reported the status of the J-PARC accelerator, mainly about the MR. He gave a brief introduction of the operation modes in the MR: FX for the neutrino experimental facility and SX to the hadron experimental facility. He explained the principal idea of increasing the beam power in either mode by increasing the number of protons and reducing the repetition cycle time. He reported the beam power history of the MR in this JFY. The beam power above 500 kW has finally been achieved in the FX mode in January 2020. MLF beam operation status was also mentioned; operation around 500kW was attained after replacing the neutron target in the MLF, followed by 1MW instantaneous operation achieved in early 2020.

Naito explained the original operation schedule of Run #82 and #83 for the period of April – July and October – December in 2019 respectively. The Run #82 had to be suspended because of the trouble with the B15D magnet in the beam transfer line from the RCS to the MR as reported in the previous PAC meeting. In Run #83 after recovering the B15D by replacing the lower coil on site, they achieved 88.2% beam availability in FX operation and 88.0% for MLF although this does not include the period while the start of MLF operation was shifted due to the delay of neutron target preparation. SX operation was not carried out after the B15D trouble in 2019.
Naito gave a beam operation schedule in the period of January – March 2020 along with a technical driven schedule of accelerator operation in the period of April 2020 – March 2021, which has to be reexamined after the operation budget is clarified. They plan to operate the MR in FX mode until February 8th in 2020 and switch to SX mode for providing beam to experiments in the Hadron Experiment Hall until around the middle of March 2020 with a possible extension of several days. They plan to reserve one week at the end of March to assemble a spare magnet in the MR tunnel. Implementation of the MR operation schedule in JFY 2020 should be discussed in this PAC meeting.

Naito then reported a few topics related to the FX and SX operations. He showed the beam loss observed in the highest power operation in January 2020 at 505kW in FX. They succeeded in minimizing and localizing beam loss to less than 1.2% below the capacity of the collimator sections. He presented how feed-back of the MR RF system worked well to reduce the loss by showing the MR power and loss trends in Run #83. He also mentioned increased dark current in an extraction septum, ESS2, where the current increases and thus the septum becomes unstable with applied voltage of 105kV. In order to compensate this instability they modified the voltage balance between ESS1 and ESS2 so that they can achieve the same beam bending with lower voltage on ESS2 ((V_{ESS1}, V_{ESS2})= (70kV, 104.4kV) to (104.4kV, 75kV)). He mentioned vertical shift of the beam center and broadening at upstream of the new branching section in the primary beamline in the Switch Yard (SY) observed during studies. The shift and broadening happen in a beam extraction spill, which is likely caused by a small instability during beam extraction near the resonance from the MR.

Naito summarized his presentation by showing a mid-term plan of the MR with a detailed operation schedule in JFY2021. They have been working on manufacturing new magnet power supplies, 2nd harmonic RF system, and FX kicker power supply improvement and new septa. These activities will be completed with their installation occurred in the long

shutdown in JFY 2021. They plan to start installation in May 2021, followed by test and beam commissioning in March and April in 2022.

2-3 Mandate to the Committee (Katsuo TOKUSHUKU, KEK IPNS director)

The director of the Institute of Particle and Nuclear Physics Studies (IPNS), Katsuo Tokushuku, welcomed the Program Advisory Committee (PAC) members. Tokushuku reminded the committee of the general mandates and the approved process for proposals. He requested the committee to give recommendations on beam time allocation in the near term (6~12 months) based on the guideline and to give advices on middle/long-term plans and on any other issues.

He described what IPNS has done after the 28th PAC meeting; Stage-2 approvals were given to the experiments E70 and E72 following the PAC's recommendations. Discussion has been made about the E56 (JSNS2: sterile neutrino) with its initial setup with a reduced number of PMT's. He mentioned that for this PAC meeting, two new proposals (P76 and P77) and one revised proposal (P75) have been received, about which he requested the PAC to make evaluations. He mentioned that no TDR for stage-2 challenge was received and no stage-2 approval request was made in this meeting. Finally, he showed a list of experiments whose progress/status to be reviewed in this meeting.

Tokushuku explained the J-PARC MR mid-term plan towards the power upgrade. The long shutdown is scheduled in 2021 to install the new power supply system for the MR magnets, to be ready for the high-power operation in JFY2022.

KEK has requested 6.5 cycle operation and extra budget for the MR power upgrade to the MEXT in JFY 2020. The first priority among the IPNS J-PARC projects is given to the completion of the MR power supply upgrade within JFY2021. Tokushuku showed the budget summary informed by the MEXT to KEK in December 2019. He explained that the total budget is at a similar level as JFY2019. The upgrade schedule is able to be kept unchanged with this level but it is necessary to reduce the operation time. The exact user operation time in JFY 2020 is still being discussed by taking account of the other resource which depends on the KEK over-all plan. Tentatively, the IPNS sets a priority on completion of the 3 hadron experiments (E40, E03 and E42) before the long shutdown, following the discussion in the previous PAC. Beam time for the neutrino experiments will be discussed between the experiment groups and KEK in the following months in the course of making a long-term plan including Hyper-K as an approved project. The PAC's input on these plans is extremely important.

Tokushuku also introduced a revised plan of Hadron Experimental Facility (HEF) Extension whose details are presented in another session. He requested the committee to give feedback on this staged plan of the HEF extension.

Before closing his presentation, Tokushuku introduced new PAC members starting from April 2020. Seven members out of sixteen will be replaced. He noted that the 2020 July

PAC meeting will be held with participation of the old and new members.

After several clarifications, the committee took note of the mandates. The guideline of the beam allocation in JFY2020 was discussed in the closed session and the recommendation is written in a separate section of the minutes.

2-4 Hadron Hall & SX Beam Status and Target R&D Plan (Hitoshi TAKAHASHI, J-PARC/KEK)

Hitoshi Takahashi reported on the status and plan of the Hadron Experimental Facility. The report included the preparation status of the new production target and construction of the new primary beam line.

First, he summarized the history of beam operation with the previous production target. It worked stably without any serious problems for 5 years after replacement. The maximum primary beam power of 51 kW was achieved in continuous user operation, which is close to the design value of 57 kW. Total operation time has reached 4909 hours, whereas the estimated life of beam windows is 7500 hours.

In order to realize higher beam power, a new production target has been constructed. It employs an indirect water-cooling system. The target is made of gold and capable of accepting beam power up to 95 kW. After tests and safety reviews on the replacement work, the target was replaced successfully last autumn. The radiation exposure to workers was well controlled during this replacement work; the accumulated dose was about half of that expected. Especially, the shielding cask system reduced the exposure dose significantly.

Next, Takahashi showed the construction status of the new primary beam line (B line). The installation of the beam-line elements was completed last September, and the shielding was also almost completed. Both of the existing and the new beam lines will be ready for beam in the beginning of next February. The commissioning plan towards the facility inspection for the license as a radiation facility along with E16 physics run was also discussed.

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

E40 (Σp)

E40 aims to elucidate ΣN interactions by measuring differential cross sections of Σp elastic scattering and the $\Sigma^- p \rightarrow \Lambda n$ conversion reaction. They have completed two production runs, in the 2018 spring (June, 2 days) and 2019 spring (February-April, 20 days for $\Sigma^- p$ and 13 days for $\Sigma^+ p$). The third production run is scheduled in 2020 spring (February-March, 1.5 days to start up and 14 days for $\Sigma^+ p$).

E40 reported results of the first and second production runs. The Σp events seem to be observed as expected. After a short summary of Σp events, the proponents reported analysis results of pp and pn differential scattering cross sections ($d\sigma/d\Omega$) obtained in E40, and compared their results with previous experimental data. The analyzed results of NN $d\sigma/d\Omega$ seem to be consistent with previous pp and pn scattering data. Surprisingly, the uncertainties may be comparable or smaller than those of previous NN scattering data. One of the reasons for this precision comes from the fact that the neutron is kinematically identified very well from the Σ^- decay into a neutron and a π^-, whose branching ratio is almost 100 %. The team demonstrated that the E40 spectrometer is able to obtain differential cross sections of baryon-baryon scattering as precisely as previous NN scattering experiments with sufficient statistics.

The PAC recognizes that the E40 analysis works well and expects that the Σp scattering and conversion reaction differential cross sections would be obtained properly. The PAC encourages E40 to perform the 2020 spring run carefully and finalize the analyses of Σp data. The PAC also encourages E40 to finalize the NN scattering analyses including systematic errors and provide an update to the existing world NN $d\sigma/d\Omega$ data after 40 years.

E03 (X-ray from Ξ^- Atom)

The plans for carrying out this important study of the atomic levels of a negative cascade hyperon bound to an Fe nucleus appeared to be progressing well. In the first stage their plan is to measure the ~172 keV X-ray from the n=7 to 6 transition, which should not be shifted significantly by the strong interaction with the nucleus. The next stage is to measure the n=6 to 5 transition and determine the shift and width of the n=5 level generated by the nuclear interaction of the cascade hyperon.

The PAC recommends that the first stage of the experiment be completed with 19.5 + 3 days running before the 2021 shutdown.

E42 (H dibaryon)

The E42 experiment aims to identify the H-dibaryon, S=-2 and B=2 six-quark state (uuddss), in the $^{12}C(K^-, K^+)H$ reaction at K1.8. Measurements of the ΛΛ, $\Lambda p\pi^-$ and $\Xi^- p$ final states with 1MeV good mass resolution, high sensitivity and wide H mass range, will provide key information on the elusive H-dibaryon.

The E42 hyperon spectrometer consists of a time projection chamber (HypTPC) and a superconducting Helmholtz magnet. In this PAC meeting, the E42 group reported the status of preparation: the HypTPC has been operated stably at the Hadron Hall; a new beam hodoscope has just become available; the TPC Hodoscope (HTOF) will be ready in February 2020, and the Water Cherenkov Detector (WCH) will be ready by April 2020. The PAC is pleased to see that the time between the pilot run and physics run has been significantly shortened. The experiment requests beam time for both the commissioning (5 days) and the physics runs (51kW, 31 days) before the long shutdown scheduled in 2021. The PAC supports the request.

E31 (Spectroscopic Study of Hyperon Resonances below KN Threshold)

The E31 experiment studies $\underline{KN} \rightarrow \Sigma\pi$ reaction in the threshold and subthreshold regions in order to clarify the complex nature of the Λ(1405), which is the lightest hyperon resonance located just below the $\underline{KN}$ threshold and cannot be described as a simple three-quark baryon. Theoretical approaches based on chiral SU(3) effective field theory suggest a double-pole structure of this state with a $\underline{KN}$ quasi-bound system embedded in the πΣ continuum. In particular, coupled-channel dynamics predicts a pole around 1420 MeV, just below the $\underline{KN}$ threshold. Study of $\underline{KN}$ interaction is also important to understand the peak structure interpreted as a K-pp bound state which was recently reported by the E15 collaboration.

By employing the K1.8BR beam line and the CDS system, the E31 experiment measured the d(K^-,n) πΣ reactions at a forward angle of n. The physics run was carried out in 2016 and 2018, and the analyzed results have been presented in the present PAC meeting.

E31 successfully obtained cross sections of the πΣ missing mass spectra in all the charge configurations ($\pi^+\Sigma^-$, $\pi^-\Sigma^+$, $\pi^0\Sigma^0$, $\pi^-\Sigma^0$) separately. Then the $\underline{KN} \rightarrow \Sigma\pi$ (I=0 and 1) scattering amplitudes were deduced. From the I=0 amplitude, the scattering length and effective range parameters were determined and the $\underline{KN}$ (I=0) pole position was found to be 1417 MeV. It is consistent with the higher one of the double poles predicted by a number of models. The difference of the I=0 spectra from two channels remains to be understood.

The PAC congratulates the E31 collaboration for the excellent results, which have clarified the $\underline{KN}$ scattering amplitude below the threshold for the first time, making a great step to solve the long-standing puzzle of the Λ(1405). Furthermore, the πΣ scattering amplitudes would be the first data in the world. The PAC recommends E31 to compare the results with existing theoretical models to demonstrate the impact of this data. The PAC is looking forward to publications of the results and further outputs from the E31 data.

P73, P77 ($^3_\Lambda$H and $^4_\Lambda$H Mesonic Weak Decay Lifetime Measurement with ^{3,4}He(K^-,π^0)$^{3,4}_\Lambda$H Reaction)

$^3_\Lambda$H is the lightest strange nucleus that provides unique opportunity for understanding hyperon-nucleon interactions. Recent results of the lifetime from high-energy nuclear collisions imply a short lifetime for the $^3_\Lambda$H that is inconsistent with the small Lambda binding energy of 0.13 MeV. In order to resolve the puzzle, a direct measurement of the decay time distribution in the ^{3}He(K^-, π^0)$^3_\Lambda$H reaction was proposed by P73. In this case, the lifetime is determined event-by-event by the time difference between the starting time and the decay product pion.

Previously, the PAC suggested to carry out pilot run with ^{4}He target in order to understand the possible background in a timely fashion. The proponents have prepared a new proposal P77 in which they reported their detailed studies on the backgrounds and

readiness of the experiment. They request a one-week 50kW 1GeV/c kaon beam run on ^{4}He target.

The PAC realizes the importance of the measurement and appreciates the careful report prepared by the proponents. The PAC suggests approval of P77 as a test experiment. If opportunity arises, P77 should take data already in JFY2019 for a short run to study background.

E16 (Spectral Change of Vector Mesons in Nuclei)

The E16 experiment aims at the measurement of the spectral change in vector mesons, especially φ-mesons, decaying in nuclei into $e^{+}e^{-}$ pairs. The first observation was reported by the KEK-PS E325 group, and the E16 experiment plans to perform a systematic study of these phenomena in the B line. The first phase of the experiment called 'Run-0 (40 shifts)' has been approved so far.

The Run-0 detector configuration consists of 6(SSD)+68(GTR)+46(HBD)+6(LG). The PAC is pleased to hear that the detector installation is well underway and it will be completed by early February. However, the installation schedule is still very tight and the detector readiness should be closely monitored.

The first 20-shift beam time assigned in the Run-0 is allocated in the coming February and March, and this is the first experiment in the B line, which was newly built. The PAC thinks the commissioning should be carefully done and, in particular, the beam intensity optimization is a key to obtaining an appropriate experimental environment. The additional 2 GTR and 2 HBD modules will be installed for another 20-shift beam run, which is scheduled in Autumn 2020. The PAC recommends to assign this beam time to E16.

The next beam time, Run-1, corresponding to 160 shifts, will be requested based on the Run-0 results. The Run-1 will not be scheduled before late 2021. In the baseline plan, the C/Cu targets will be used, which is the same as in the Run-0. The PAC suggests that the possible potential advantages of using a Pb target in the Run-1 period should be reconsidered.

E70 (Spectroscopic Study of Ξ-hypernucleus)

The purpose of the E70 experiment is to study Ξ^{-}-hypernucleus $^{12}_{\Xi}$Be through the missing mass study of the ^{12}C(K^{-}, K^{+}) reaction. The binding energies of the states in this nucleus will provide information on the nuclear potential of Ξ^{-} hyperons. This measurement complements studies of Ξ^{-} hyperatoms and of two-body correlation functions in heavy ion reactions. Following the recommendation of the PAC28, the experiment was granted stage-2 approval.

The collaboration presented a detailed analysis of the E05 pilot run data, which was taken in 2015. They show that the E05 missing mass spectrum is compatible with data obtained earlier by E885 at BNL. Both experiments show a consistent strength in the bound region, which may signal the presence of bound states. Despite the better resolution of E05

(5.4MeV FWHM) compared to E885 (14MeV FWHM), the limited statistics of this pilot run does not, unfortunately, allow clear identification of Ξ-hypernuclear states in the bound region at the present stage of the analysis.

The E70 also presented an update on the preparation of the newly developed active target system. This new piece of equipment is essential to reach an energy resolution of about 2MeV (FWHM) in the E70 run. The construction of this target station is proceeding very well and tests performed at ELPH in Tohoku showed that the system works according to expectations.

The PAC was happy to see these developments and looks forward to a successful run of E70 after the long shutdown in JFY2021.

P75(Measurement of the formation cross section of $^{7}_{\Xi^-}$H)

P75 aims to detect the $^{5}_{\Lambda\Lambda}$H hypernucleus, presumably the lightest double Λ hypernucleus, and to measure its binding energy via the ^{7}Li(K^-,K^+) reaction in coincidence with the sequential pionic weak decay of $^{5}_{\Lambda\Lambda}$H . The experiment provides invaluable information on the Λ−Λ interaction, particularly the effect of the ΛΛ−ΞN mixing by combining with the other ΛΛ hypernuclear data such as $^{6}_{\Lambda\Lambda}$He. The main obstacle in doing this experiment is that the $^{5}_{\Lambda\Lambda}$H yield depends on the yet unknown cross section of ^{7}Li(K^-,K^+)$^{7}_{\Xi^-}$H.

To clarify this issue, the P75 collaboration suggests a staged approach. During so-called Phase-1, the collaboration aims at a measurement of the relevant cross section. There might also be a chance to observe a peak structure in the bound state region, which would nicely complement the measurement of E70.

The experimental setup for P75/Phase-1 is nearly identical to the E70 apparatus. Replacing the complex active target system of E70 by the much simpler, passive ^{7}Li target, enables a fast conversion from the E70 to P75 setup. Therefore, running both experiments in a row might enable in an efficient use of resources.

The committee welcomes this staged approach for P75 and recommends stage-1 approval for the Phase-1 run. The requested 7 days of running for this measurement is appropriate.

E63 (Gamma-ray spectroscopy of light hypernuclei)

E63 aims at elucidating the ΛN interaction in nuclei and medium effects of Λ via γ-ray spectroscopy. For the ΛN interaction, E63 plans to measure the 1^+-0^+ energy difference of $^{4}_{\Lambda}$H precisely to quantify the charge symmetry breaking. For the medium effects of Λ, measurement of Λ spin-flip B(M1) is planned to extract the magnetic moment of Λ (g_Λ) in a nucleus of $^{7}_{\Lambda}$Li. Stage-2 status for E63 was approved in July 2016. The latter part of measurements was proposed as a part of the previous experiment, E13, and stage-2 was approved in 2006. The requested beam time is 6 days and 35 days at 50 kW for these measurements, respectively, and the 19 days for beam tuning, commissioning and various control runs in the K1.1 beam line.

The proponents reported the progress after the July 2016 PAC. All the detectors are ready, Li_2O single crystal for the B(M1) measurement target has been successfully produced, precise calculation for ${}^{7}_{\Lambda}$Li B(M1) with Λ-Σ mixing effect included will be finished soon by Hiyama, and they also plan to install a small range counter array to identify ${}^{3}_{\Lambda}$H hyper-fragments to measure ${}^{3}_{\Lambda}H^{*}(1/2;T=1) \rightarrow {}^{3}_{\Lambda}H(1/2,3/2;T=0)$ γ-ray as a byproduct. E63 will be ready for running in 2021. The PAC appreciates the preparation.

E63 plans to perform the experiment in the K1.1 beam line and requests to construct the beam line during the long shutdown held in JFY2021. The PAC understands that E63 collaborators have been waiting for the K1.1 beam line for a long time. Since such a construction has implication for the B line, discussion will be made in one of the coming PAC meetings after the phase-0 run of E16.

E11/E65 (T2K and T2K-II)

T2K is a long-baseline neutrino oscillation experiment using an intense muon (anti-muon) -neutrino beam from J-PARC MR to Super-Kamiokande. The collaboration reported the status of data taking in JFY2019. They had stable operation with beam power of 496kW in November 5 – December 19, as Run10, giving 2.65E20 POT (nu-mode). In total T2K-I has collected data with 3.43E21 POT, which is 44% of their goal. An additional 0.19E21 POT is foreseen to be collected in January 14 – February 12, 2020.

Several hardware troubles were reported: water drops from HORN1, increase of leakage current of the Si detector in the muon monitor due to radiation damage, ND280 magnet chiller problem, etc.; some of these problems were fixed. Unexpected trouble with the overhead crane in the ND280 hall occurred during the magnet work. $NC\pi^0$ and ν_e measurements without the magnet are performed until the problem is fixed in Feb 2020.

They reported on the latest T2K results: 89% preference for normal mass hierarchy, 2-sigma indication for CP violation, and the first 3-sigma constraint on CP-delta that has been submitted to the journal NATURE. Various new cross-section measurements such as CC0pi for ν_μ on carbon and oxygen are reported. A kick-off combined analysis with NOνA was reported and the PAC looks forward to updates on this activity.

The PAC heard an update on the status of SK-Gd. After 3-weeks of new Gd-water system commissioning, no degradation of water transparency was observed. They plan an additional minor tank opening, 12–25 February, to put caps on the outlets of pipes at the bottom of the tank to reduce convection in the water. In April 2020, $Gd(SO_4)_3$ will be dissolved for 1 month to achieve a Gd concentration of 0.02%, followed by 3 months of commissioning and 3-months of calibration. By October 2020, SK-Gd will be ready for beam. The PAC believes that this schedule is credible. We heard that T2K beam events obtained with SK-Gd are useful for understanding the NCQE background in the diffuse super-nova analysis. They have requested 4E20 POT (52days) to get ~17 neutron-tagged NCQE events, yielding a 25% statistical error for background subtraction.

Given the current measured CP violation at Confidence Level close to 99%, the T2K collaboration has emphasized the importance of continuous increase of statistics to keep international competitiveness and further reduction of systematic errors in neutrino interactions with the newly installed WAGASCI-Baby MIND to obtain similar statistics to those of the existing ND280. To accomplish this, they request an additional 9.2E20 POT (120 days) in JFY2020. Their minimal request is 4E20 POT (52 days) for collecting data with SK-Gd.

The PAC recognizes the importance of continuing T2K operation and their JFY2020 request. Discussion of beamtime allocation can be found in the last section of this minutes.

Prospects of T2K-II were presented by the collaboration. There were updates on various successful R&D efforts for the ND280 detector upgrade. The assembly procedure of the Super-FGD was established. All MPPCs and WLS fibers for the Super-FGD were delivered in JFY2019. A neutron beam test at LANL was performed in Dec 2019 and data analysis is on-going. With Hyper-K construction approved, the collaboration emphasized that at least 10E21 POT is desirable for advancing the program of Hyper-K, as recommended by the neutrino community panel formed by T2K and Hyper-K members. The PAC was informed that the upgraded ND280 providing improved high-angle acceptance and lower proton energy threshold will give a 500K mu-p sample with 10E21 POT, which will likely reduce the main systematic error due to modeling of the neutrino interactions.

The PAC congratulates the team on the successful progress of the ND280 upgrade work and running of WAGASCI-Baby MIND.

E56 (Sterile Neutrino Search)

The JSNS^2 experiment (E56) plans to search for eV scale sterile neutrinos with an improved stopped pion source compared to LSND. Overall, the expected sensitivity of the experiment with half the number of larger-aperture PMT's (total photocathode coverage down by 20%) is almost identical to the initial proposal. All 120 (10") PMTs for the new detector configuration have been installed in the detector assembly area after pre-validation rejected 3 PMTs. Detector transport to MLF is planned for February 12, with filling preparation through the end of the month (about a month later than the plan presented at the last PAC meeting). Gd-LS donated by Daya-Bay was delivered to Japan in August 2019; the measured transmittance of samples at the storage area looked good. The MLF facility safety team "made go sign" for installation and filling. The weight of the gamma-ray shield was reduced by a factor of 3.5 by replacing much of the steel with lead.

The PAC congratulates the collaboration for the steady progress achieved in a very tight schedule and looks forward to a report on initial detector performance in the beam at our

next meeting. The PAC looks forward to a positive outcome from the LED testing of the PMTs after detector transport but does not need to approve the result.

E71 (NINJA)

E71 (NINJA) is an experiment to study neutrino-water interactions with an emulsion-water sandwich detector. The NINJA emulsion water target is currently located in the middle of the WAGASCI detector so that muons leaving NINJA can be momentum and charge analyzed by BABY-MIND. This allows NINJA to measure muon neutrinos and antineutrinos separately and NINJA showed some event rates for neutrinos and antineutrinos separately in both the forward and reverse horn current beam from their first exposure of beam, which was 0.4×10^{20} POT in neutrino mode and 0.7×10^{21} POT in antineutrino mode. They are preparing a first publication on these data, although the publication will only include event rates rather than cross sections because the statistics were low on the pilot run.

NINJA started taking physics data in November 7 2019 and showed a plot demonstrating event rate stability and event displays from this new run. They have recorded 2.64×10^{20} POT so far in neutrino mode and expect to receive up to 4×10^{20} POT by the end of JFY2019. The stepping motors were reported to operate well, these allow a timestamp of 4 hours to be given to events in the NINJA emulsion. A total of 10×10^{20} POT were requested in neutrino mode for the detector but emulsions will be removed and analyzed after the 4×10^{20} POT are collected.

The PAC congratulates the NINJA collaboration on the progress in taking data and looks forward to seeing the physics analyses that result from this exposure.

E14 (KOTO)

The E14 (KOTO) experiment searches for the CP-violating decay $K_L \rightarrow \pi^0 \nu\nu$ at the J-PARC neutral beam line. KOTO first described what were presented at the KAON2019 conference on the analysis of the 2016–2018 data. Features of this data set include addition of the Inner Barrel veto, new FPGA-based trigger/DAQ hardware and a special run to collect neutron-rich control samples. New analysis techniques on the pattern of CsI-calorimeter hits and Fourier transformation of the CsI-calorimeter waveforms reduce the hadron cluster background. The single-event sensitivity (SES) of this data set is 7×10^{-10}. Compared to the published 2015 data, the new kinematic signal box is 6% larger. The acceptance of veto cuts was increased by 10% with a Fourier transform of pulse shapes to better identify overlapping hits in a given channel. The 2016–2018 data sample has 1.57 times more K_L and 1.2 times better acceptance than the 2015 data sample. The estimated background in the signal box is 0.05 ± 0.02 events (after more than x10 suppression of hadron cluster background). Four events were found in the box and one outside the box in the blinded area. Post-blinding analysis includes detailed study of each event:

- Event #1 in Run69 appears to have an in-time event in the NCC veto counter that is masked by an accidental hit. The event was further characterized by separated readout of individual NCC channels.
- Event #2 in Run69 has no hits in the veto detectors, but lies at the end of spill as the intensity is rapidly dropping.
- Event #3 in Run74, mistake in timing peak selection parameter for HINEMOS detector.
- Event #4 in Run79 just barely earlier than veto window in forward barrel.
- Event #5 in Run79 has no hits in the veto detectors (outside kinematic signal box).

A newly identified background from K^+_{e3} produced from K_L scatters or decays interacting on the downstream collimators increases the background estimate to 0.34 events. KOTO continues re-evaluating backgrounds comprehensively.

With the 2016-2018 data, KOTO also studied an exotic decay $K_L{}^0 \to \pi^0\gamma$ and has set the first limit: BR < 1.7×10^{-7} at 90% C.L.

The 2019 data set was taken after completing detector upgrades including MPPCs on the front face of the CsI calorimeter so that timing measurements can further discriminate between gamma- and neutron-generated signals. The new downstream charged veto counter inside the high vacuum beam pipe effectively reduces the backgrounds in the low Pt region. This data set has an estimated SES of 8×10^{-10}, bringing the total data set SES to 3×10^{-10}, well below the Grossman-Nir bound.

A new iron wall was installed in December 2019 to reduce accidental background. A new upstream CV is added to tag K+ in advance of Feb-Mar run. The plan is for an initial set of special runs to understand backgrounds and then a long physics run before the 2021 shutdown. E14 requests at least 40 days of running time at 70 kW beam power to bring the SES of their total data set to 2×10^{-10}.

The PAC looks forward to improved KOTO understanding of the 2016–18 analysis results in a timely fashion and endorses their request for beam.

E36 (Lepton Universality)

E36 is an experiment aiming to test lepton universality using the ratio R_K of branching ratios Br($K^+ \to e^+ \nu_e$) over Br($K^+ \to \mu^+ \nu_\mu$). The collaboration presented to the PAC their preliminary results on the structure dependent background process $K^+ \to e^+ \nu_e \gamma$, finding a branching ratio of $(2.02 \pm 0.12) \times 10^{-5}$, using Run-1 and Run-2 data and three different analysis approaches, with consistent results. The combined measurement deviates by more than 3σ from the previous KLOE result.

The PAC congratulates the collaboration on accomplishing this important achievement, and encourages a timely completion of the analysis. The PAC looks forward to its

presentation for the next PAC meeting, including the R_K final result, and expects a submission for publication of these important final results.

E21 (COMET)

The E21 (COMET) collaboration aims to observe charged lepton flavor violation (CLFV) through the μ to e transition in muonic Aluminum atoms, thereby allowing a probe of very high-energy scales for possible New Physics processes. The TDR for Phase-I was accepted for publication in October 2019.

The collaboration continues to expand, although slightly. The strengthening of the collaboration internal organization was presented, as illustrated for instance by the identification of a person responsible for the proton target, and the formation of a task-force to prepare the COMET beam line construction.

The PAC is pleased to learn that a confirmation of the Proton Extinction scheme is foreseen, using the bunched-SX beam, with a concrete proposal under preparation. Detector progress on several fronts was presented. Discussion with IN2P3 for a computing MoU was initiated, although, at this point, the CPU computing resource needs cannot be formulated yet, in particular because the tracking needs for CPU remain to be assessed. A mass production of Monte Carlo (MC5) full simulation is planned to start soon, including a Mock-Data challenge. The PAC assumes that the corresponding computing resource needs have been addressed.

A rough schedule leading to the start of commissioning early JFY2023 was presented; it was identical with the one shown at the previous PAC meeting, without a more detailed breakdown that the PAC was expecting. Because of possible funding issues, it appears that the solenoid construction could become a bottleneck. In light of the international competition, the PAC reiterates the obvious importance of a timely start.

The PAC expects that the proposal for the SX beam-time request will be provided for the next PAC meeting. The PAC supports the E21 request to KEK for continuing support from the Beam Line (BL) group and from the mechanical engineering group.

Overall, the PAC congratulates the COMET collaboration for its continuous steady progresses and achievements.

E34 (g-2/EDM)

The E34 experiment aims to measure the muon g-2 and electric dipole moment. They reviewed the experimental concept and presented responses to the previous PAC recommendations, including: inclusion of critical R&D milestones into the schedule, a more detailed cost & schedule, progress towards the H-line building.

The experiment reported on an expected new g-2 calculation from the g-2 theory initiative next month. They showed subsystem schedules and an overall technically driven schedule with commissioning in 2024 and a physics run in 2025-2026. E34 showed a list of issues from meetings of a task force on the H-line building extension. They described recent R&D progress. Laser ablated silica aerogels without warping have been demonstrated. Two plans for laser ionization are under development (1S-2P-ionized or 1S-2S-ionized) with tests planned in the U-line and S-line. The aim is to meet the muonium ionization milestone in JFY2020. An RF coupler for the IH-LINAC and beam instrumentation have been developed. Data from spiral injection test performed with an electron beam was shown. US-Japan collaboration on B-field calibration continues. Silicon detector development continues. Several publications have been made.

The PAC would like to see more detail on the manpower distribution within the internal organization of the collaboration and encourages E34 to expand its international component: as of now E34 is essentially Japanese (70%) and Korean (15%).

The PAC endorses the E34 request for support of completion of the H-line in mid JFY2020, survey and studies of the H-line building extension and lab support for ionization of muonium from silica aerogels.

P76 (Neutron T violation)

As already demonstrated for parity violation, the existence of close-lying levels of opposite parity in carefully chosen nuclei can lead to an enormous enhancement of the violation of fundamental symmetries. This experiment aims to exploit two close lying compound states in ^{140} La through the measurement of a cross section involving a T-violating spin correlation in the scattering of epithermal neutrons from ^{139}La. Theoretical analysis suggests that this measurement is sensitive to the same T-violating pion-nucleon coupling constant which gives rise to the neutron electric dipole moment. Most significantly one can access this fundamental physics through a measurement of an asymmetry at the 10^{-4} level. This is a very important measurement for which the control of systematic errors is critical.

The PAC heard the discussion about the proposal for a new beamline at MLF, the neutron polarizer and the polarized target development as well the experimental apparatus for the measurement. The material presented was not enough to begin to evaluate the proposal's feasibility, time-scale, or the budget. The PAC would be prepared for an evaluation when appropriate material is made available. PAC would likely form a subcommittee with supplemental members as many of the aspects of this proposal require specialized knowledge to evaluate.

4. General Remarks and Recommendations

The committee was pleased to hear the steady progress on all fronts at J-PARC. The MR power upgrade planned for JFY2021 is on track with the expected start of the upgraded MR in May 2022. As we have stated before, a timely startup and return to full utilization of 9 cycles per year is very important in view of the many scientific questions to be addressed with the upgraded machine. We are pleased to learn of the continued progress towards the availability for the B line in February 2020, with the COMET beamline to be complete as early as the end of JFY 2021. We were also pleased to hear that the timely installation of the new target in the Hadron Hall, as well as the successful repair of the B15D magnet. We congratulate the accelerator team for achieving steady running above 500 kW in FX.

The PAC heard about the plans for Hadron Hall extension with exciting possibilities for unique precision hypernuclei measurements, and the extension of the reach of KOTO by two orders of magnitude, among others. As the PAC have heard these plans, in some detail, for the first time, and as the material presented was relatively limited, the committee cannot make extensive comments at this time; PAC would be prepared to evaluate the scientific and technical case for such an extension in the future.

The PAC heard the news that the Hyper-K program has been approved and the first funding has already been established. The committee congratulates KEK and J-PARC on this exciting and important development for the global physics community. There will be an obvious impact on J-PARC, both in planning and operations. The HK program requirements, 5.3 cycles/year, for J-PARC operations will be large compared to the available beamtime in the recent years. Sufficient operation budget and careful operations planning will be required for the healthy development of all scientific programs at J-PARC in the future.

Previously, the PAC strongly recommended that every effort be made to restore the beamtime availability at J-PARC to at least 6 months per year during the period of upgrades towards 1.3MW and to the full 9 months per year afterwards. It is therefore with great concern that PAC heard about the limited operation budget for JFY 2020.

We concluded that our previous recommendation of giving priority to the suite of experiments E40, E03 and E42 still remains valid, at this point, as this will allow for the reconfiguration of experiments in the Hadron Hall during the long shutdown. In the current scenario, E40 will complete within JFY 2019, and a large portion of E42 will be done at the beginning of JFY 2021 before the shutdown, leaving the running of E03 and a part of E42, corresponding to a very limited running of about 25 days of SX running, for JFY 2020, with an additional 8 days needed for accelerator studies; an effort should be made to accommodate other small test requests of SX. The request for FX running from E11(T2K) fits naturally during the 3-month break between E03 and E42, also considering the readiness of SK-Gd for data taking. The PAC recommends that FX running be tentatively scheduled after the completion of E40 although it was not clear at this meeting what the final budgetary constraints for JFY 2020 would be. The PAC will revisit the schedule in the next meeting.

The previous recommendation of increased beam availability was not only based on the need to avoid very serious delays of the experiments, but also on the harm to the future viability of the J-PARC scientific program, as physicists, both domestic and international, inevitably look elsewhere for competitive projects at facilities that can support their research in a timelier way. This time, PAC heard this type of concern reiterated strongly from the T2K collaboration. We recommend that a full discussion of this issue should take place at the upcoming meetings between the neutrino experiments and KEK about the long-term plans in view of the now-approved Hyper-K project.

5. DATES FOR THE NEXT J-PARC PAC MEETING

The next J-PARC PAC meeting will be held July 20-22, 2020.

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

- Minutes of the 28th J-PARC PAC meeting held on 16-18 July, 2019 (KEK/J-PARC-PAC 2019-16)
- Proposals:
    - Feasibility study for 3\Lambda H mesonic weak decay lifetime measurement with 4He(K^-, pi^0)4\Lambda H reaction (KEK/J-PARC-PAC 2020-1)
    - Phase-1 of the P75 experiment : Measurement of the formation cross section of ^7_\Xi^- H in the ^7Li(K^-,K^+) reaction (KEK/J-PARC-PAC 2020-2)
    - Searches for the Breaking of the Time Reversal Invariance in Polarized Epithermal Neutron Optics (KEK/J-PARC-PAC 2020-3)