KEK/J-PARC-PAC 2024-5
July 30th 2024

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

Minutes of the 37th meeting held
24(Wed.)-26(Fri.) January 2024

<u>OPEN SESSION</u>:

1. Welcome and J-PARC Center Report: T. Kobayashi (J-PARC/KEK)
2. J-PARC Accelerator Status & Plan: Y. Sato (J-PARC/KEK)
3. Mandate to the Committee: N. Saito (KEK)
4. Hadron facility status & Plan: H. Takahashi (J-PARC/KEK)
5. E16: Measurements of Spectral Change of Vector Mesons in Nuclei: S. Yokkaichi (RIKEN)
6. E42: Search for H Dibaryon with a Large Acceptance Hyperon Spectrometer: Y. Ichikawa (JAEA)
7. E72: Search for a Narrow Λ^* Resonance using the $p(K^-,\Lambda)\eta$ Reaction with the hypTPC: S. Hayakawa (Tohoku Univ.)
8. E70: Ξ Hypernuclear Spectroscopy: T. Gogami (Kyoto Univ.)
9. E63: Gamma-ray Spectroscopy of Light Hypernuclei: M. Ukai (J-PARC/KEK)
10. E73: Lifetime Measurement of ${}^{3}_{\Lambda}H$: Y. Ma (RIKEN)
11. E80/P92: Systematic Investigation of the Light Kaonic Nuclei: F. Sakuma (RIKEN)

12. T98: Measurement of Anti-Matter Reaction in Liquid Argon Time Projection Chamber (LArTPC): M. Tanaka (Waseda Univ.)

13. P95: Proposal for "Pion-induced phi-meson production on the proton": T. Ishikawa (Osaka Univ. RCNP)

14. P102: Study of the Peculiar Bump Structure at 1680 MeV by the $\pi^{-}p \rightarrow \eta n$ Reaction with Momenta of p_{π}=0.85-1.2 GeV/c: H. Kohri (Osaka Univ. RCNP)

15. MLF Particle and Nuclear Physics Programs: N. Saito (KEK)

16. P99: Study of Discrete Symmetries in Polarized Epithermal Neutron Optics: H. Shimizu (Nagoya Univ.)

17. P100: Fundamental Physics with Pulsed Cold Neutrons: K. Mishima (J-PARC/KEK)

18. E14(KOTO): T. Nomura (J-PARC/KEK)

19. E11/E65 (T2K): Introduction, analysis plans: K. Mahn (Michigan State Univ.)

20. E11/E65 (T2K): Beamline, SK and ND upgrade status and plan: T. Lux (IFAE)

21. E21(COMET): Y. Uchida (ICL)

22. E34(g-2/EDM): T. Mibe (J-PARC/KEK)

23. E56/E82(JSNS2, JSNS2-II): T. Maruyama (J-PARC/KEK)

24. E71(NINJA): T. Fukuda (Nagoya Univ.)

25. Hadron Hall K1.8/K1.8BR plan and request summary: M. Ukai (J-PARC/KEK)

26. Beam Time Schedule: T. Komatsubara (J-PARC/KEK)

CLOSED SESSION:

Present: P. Achenbach (Mainz), V. Cirigliano (Washington), M. Endo (KEK), L. Fields (FNAL), H. Ishino (Okayama), D. Jaffe (BNL), K. Joo (Connecticut), T. Kawabata (Osaka), C. Lazzeroni (Birmingham), K. B. Luk (Berkeley), K. Miyabayashi (Nara), H. Ohnishi (Tohoku), M. Oka (JAEA), K. Yorita (Waseda), T. Yamanaka (Chair, KEK),

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

1. PROCEDURAL REPORT

The minutes of the 36th J-PARC-PAC meeting (KEK/J-PARC-PAC 2023-11) were approved.

2. LABORATORY REPORT

2-1 Welcome and J-PARC Center Report (Takashi Kobayashi, J-PARC Center Director)

The J-PARC Director, Takashi Kobayashi, delivered a welcome address and a report on the J-PARC center. He announced that after two fire incidents in 2023, neutrino (NU) operation resumed on November 21 as scheduled, and MLF operation resumed on December 3, albeit with a slight delay due to a problem in the MLF target. He discussed countermeasures against fire, including the elimination of the polarity-changers using rotating electrodes at the hadron experimental facility (HD), and the replacement of very old power supplies, aged 39 years or more, with new ones. Additionally, measures have been implemented J-PARC-wide, such as the inspection of all power supplies, prevention of combustible materials near power supplies, improvement of the interlock system, and temperature monitoring. The resumption schedule for HD depends on the implementation of countermeasures, but it is expected to be around April 2024.

Kobayashi also reported that the long-awaited assembly building at J-PARC was finally funded in April 2023, and its construction has started. The building is called SOKENDAI Joint Research Center / J-PARC Experimental Equipment Development Building. Furthermore, he reported that the long-awaited access road is partially funded, and construction will begin in FY2024.

A MEXT review of the entire J-PARC took place in November-December 2023. Achievements were highly commended, but several areas for improvement were pointed out, including continuous efforts to ensure safety, to address aging issues, and to secure funding. On aging issue, although many components were built after 2000, old power supplies were still in use, particularly in the HD facility. In response to this issue, the very old ones, aged 39 years or more, have been eliminated. Renewal of the other old power supplies is necessary for future stable operations.

In 2022, electricity costs skyrocketed. JFY2023 saw a slight reduction, but costs remain quite high, almost double compared to those in 2010.

Kobayashi summarized the approved budget for JFY2024, including the FY2023 supplementary budget. For operation, the same amount as in JFY2023, 101.8 billion yen for 7.2 cycles (JAEA) and 53.08 billion yen (KEK) were secured. In JFY2023, the KEK operational budget provided 6.5 cycles. Additionally, 1.23 billion yen for the muon g-2/EDM project and 3.01 billion yen for aging countermeasures for accelerators were approved. For the Hyper-K project, 5.76 billion yen for a power upgrade and 0.86 billion yen for a near detector facility were secured.

He announced that the J-PARC Symposium 2024 will be held in October 2024. It aims to present and discuss scientific achievements in the past 15 years, and future projects for the next 20-30 years.

2-2 J-PARC Accelerator Status (Yoichi Sato, J-PARC/KEK)

Yoichi Sato presented the J-PARC accelerator status and plan, highlighting the MR beam power upgrade strategy, particularly focusing on achieving a higher repetition rate of a factor 2 as well as increasing the beam intensity by about 30%. Despite encountering various problems, including damage to the Insulated Gate-Bipolar Transistor (IGBT) circuit used in the newly installed magnet power supplies, all issues were successfully addressed, and ongoing optimization work is being conducted for improved performance.

After the replacement of the MR power supplies, the accelerator achieved 8-GeV operation in Feb.-Mar. 2023. Subsequent milestones included MR FX 760-kW operation (demonstration) in Apr. 2023, and MR SX 50-kW operation in Jun. 2023. Notably, beam performance was successfully reproduced even with a short beam-tuning period.

In terms of recent progress after Sep. 2023, the MLF user operation demonstrated a remarkable 94% operation efficiency in Dec. 3-25. MR operation in FX during Nov.-Dec. 2023 reached 600 kW after Nov. 23, and 710 kW after Dec. 14, ultimately achieving 760 kW on Dec. 25. A key challenge of the 710-kW user operation is residual radiation dose, which will be a focal point in the near future. The 760-kW operation necessitates further reduction of beam loss.

Looking ahead, the accelerator operation plan for Jan.-Mar. 2024 has FX operation in Feb. 2024, SX/MR-Abort Dump (MR-ABD) beam study in Mar., and MR maintenance in Mar.-Apr. The plan shows ongoing commitments to advance the J-PARC accelerator's capabilities.

2-3 Welcome and Mandate to the Committee (Naohito SAITO, KEK IPNS director)

The director of the Institute of Particle and Nuclear Studies (IPNS), Naohito Saito, welcomed the PAC members. He first introduced the organization structure of the IPNS which covers a wide range of scientific researches.

Among the current status of IPNS projects, he highlighted the recent progress in J-PARC Main Ring accelerator on the achievement of >760 kW continuous beam operation. He also mentioned that beamtime and aging are recent issues in J-PARC but MEXT understands the current situation and their support would be expected to mitigate those issues.

Timeline of various ongoing and future large-scale projects of IPNS was shown, and various task force meetings had been launched to promote these projects. The Hyper-Kamiokande (HK) project is one of the large-scale projects in which KEK takes responsibility on the J-PARC accelerator and neutrino beamline upgrade toward 1.3 MW and the near neutrino detector upgrade including new facility construction of Intermediate Water Cherenkov Detector. A standing advisory committee for HK (HK project advisory committee, HKPAC) was established by the Institute for Cosmic Ray Research, the University of Tokyo and IPNS, KEK. He also mentioned that the J-PARC operation for HK would be discussed in the J-PARC PAC in future.

Prospects of electricity price and beam time were explained. The electricity unit price decreased since last April. Execution of already allocated beam time to FX and SX (including commissioning time) is expected to take place until April, and three months of operation is expected in the next fiscal year before the summer shutdown. IPNS is working to secure more beam time after the summer shutdown.

Saito shared the information on a series of IPNS workshops and promoted to the community for any ideas on new workshops.

He presented Taku Yamanaka would take role of the chairperson from this meeting and a half of the current PAC members would be replaced and the next meeting which will be held jointly with the current and new members.

New documents submitted to this PAC meeting were summarized; several reports from T98, P99, P100, E63; one addendum from P95; and two new proposals regarding a test experiment at the neutrino facility (P101), and an experiment at Hadron Hall (P102). No Technical Design Report (TDR) for Stage-2 request was submitted and thus Facilities Impact and Financial Committee (FIFC) meeting was not held for this PAC meeting.

Saito requested the PAC to evaluate the new proposals along with requests for Stage-1 status and Stage-2 approval to provide recommendations to the IPNS and J-PARC directors. He also requested the PAC to assess the progress in the ongoing experiments as well as any advice on the run plan in the next fiscal year. He also reported that the new proposal P101 for a test experiment was approved after being evaluated among the PAC chair, FIFC chair, and the head of J-PARC Particle & Nuclear Physics Division.

2-4 Hadron Facility Status and Plan (Hitoshi Takahashi, J-PARC/KEK)

Hitoshi Takahashi reported on the status and plans for the next beam time at the hadron experimental facility (HD). He described details of the fire incident that occurred at HD Power Supply Building on June 23, 2023, attributing the cause to a broken polarity-changer that used rotating electrodes which failed due to material fatigue. As countermeasures, all polarity-changers using rotating electrodes and old power supplies, aged 39 years or more, were removed or replaced. After the replacements, HD still has 55 power supplies manufactured before 1999, indicating that their systematic replacement is necessary. The interlock system of power supplies was improved. Also, much of the electronic equipment was carefully inspected.

He also discussed maintenance and upgrade works during the 2023 summer shutdown. These included maintenance of the vacuum system for the K1.8 electrostatic separator, installation of a new sweeper magnet for KL, and replacement of the vacuum pipe at the B-C lines branching point. The complex-shaped vacuum pipe at the B-C lines, which was found to have a vacuum leak in January 2023, was replaced with a new one with an improved shape to reduce stress. HD is expected to be ready for beam operation at the beginning of April 2024.

Furthermore, Takahashi reported on the R&D status of a rotating production target. The current production target has a capacity of 95 kW at a 5.2-s cycle, but to receive beam power exceeding 150 kW, a rotating production target is being developed. Robustness is a key to the target, and tests for severe incidents such as earthquakes and power failures were performed. The earthquake test results had been previously reported. He reported the effects of power failure. Gas is supplied to levitate the shaft of the gas bearing to avoid friction. Power supply failures will stop the gas supply, causing hard landing of the shaft on the bearing which may damage the target system. The initial prototype using a gas bearing made of SUS630 failed when the power was turned off at 120 rpm, leading to shaft deformation. On the other hand, a bronze-alloy bearing showed no failures up to 600 rpm, with negligibly small shaft deformation. Despite anticipating up to 10 power-failure events over its lifetime, the test was performed 100 times at 500 rpm without serious damage. He concluded by outlining ongoing efforts to complete R&D, with plans to finalize the detailed design in FY2024.

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

E16 (VM in nuclei)

E16 aims to confirm partial restoration of chiral symmetry in the medium by looking at $\phi \rightarrow e^+e^-$ invariant mass spectrum using various element targets.

In this PAC, E16 collaboration showed the results obtained with the 2023 June run data to understand the beam's microstructures that cause serious data acquisition deadtime. PAC is pleased to hear that new optics at the Lambertson magnet reduces the 5.2-microsec interval component. The 5-ms interval component still exists, but it is expected to be improved after the new magnet power supplies are fine-tuned.

With a reinforced DAQ system featuring data buffering mechanism on an on-board RAM, the busy time per event is reduced from 800 microsec in the previous run to 100 microsec. The live-time-fraction recovered to 80% in the 2023 June run. All the data in June was taken using a minimum-bias trigger, and the performance with the main trigger (ee-trigger) will be checked at the beginning of the next run.

Since the beam can be delivered to the high-momentum beam line in parallel with other slow extraction beamlines, and with the progress that has been made as mentioned above, PAC recommends allocating the beam time as requested.

E42 (H dibaryon)

E42 aims to search for the H-dibaryon via the C(K^-, K^+) reaction. In PAC 37, E42 presented the progress of data analysis for the KURAMA spectrometer regarding scattered particles and the HypTPC for decayed particles. They demonstrated clear particle identification capabilities in both the KURAMA spectrometer and the HypTPC. Additionally, the proponent presented a (K^-, K^+) missing mass spectrum using CH_2 target data, revealing distinct peak structures for Ξ and Ξ*. Furthermore, the proponent exhibited a reconstructed Λ and Ξ invariant mass spectrum measured by the HypTPC. By combining the missing mass analysis with the KURAMA spectrometer, and the invariant mass analysis with the HypTPC, they demonstrated that the Λ and Ξ reconstructed by the HypTPC are the decay products of Ξ, which were produced via the primary reaction, i.e., the (K^-, K^+) reaction. While the performance of the KURAMA spectrometer met the designed values, the proponent reported that the resolution of the HypTPC did not reach the expected level. They are still working on the issue, specifically on the calibration of the HypTPC. Even though E42 presented a clear Λ reconstructed spectrum and identified about 6000 events containing two Λ's, the proponent claimed that the H-dibaryon signal box, i.e., the invariant mass of Λ-Λ, would only be opened after confirming that the analyses are completed.

The proponent also presented a list of data analyses that can be accessed using the E42 data that has already been accumulated. Among them, the proponent presented a preliminary analysis result to study the Ξ-A interaction, which can provide access to the Ξ-escaping interaction in the (K^-, K^+) reaction. The analysis is in progress.

The PAC congratulates the successful progress of the project in various aspects and encourages efforts to enhance the physics output from the already acquired data. However, the PAC is also eagerly awaiting the opening of the H-dibaryon box in the invariant mass distributions of Λ-Λ and Ξ-p.

E72 (Λ^* Resonance)

E72 aims to establish a narrow Λ* resonance with J=3/2 and to determine its parity. The quark model does not predict the resonance state; it might be described as an exotic hadronic state, such as a penta-quark baryon or hadron molecule. The angular distributions and Λ polarizations in the Kp→Λη reaction will be measured by using the HypTPC at the K1.8BR beamline.

The proponent presented readiness for the experiment. The modification work for the HypTPC has been done successfully for a target holder and a new gas vessel. The gas tightness was confirmed, and the test with cosmic rays to search for working parameters of the HypTPC is in progress at Tohoku University. In addition, Cherenkov counters, namely Kaon Veto Cherenkov counter (KVC) and Beam Aerogel Cherenkov Counter (BAC), have been tested with a positron beam at KEK-AR. The test results indicated that those counters are also ready to be used for the experiment.

The E72 collaboration requested 4 hours of beam time before the summer shutdown in 2024 to check the beam profile and intensity. After changing the detectors from the current Cylindrical Detector System (CDS) to the Hyperon Spectrometer, the collaboration requests eight days of physics run at 80 kW, and six days of calibration run, as before. The time to change the detector system was extended from 6 months to 9 months.

PAC congratulates E72 on their steady progress and recommended conducting 4 hours of beamtime before the summer shutdown. In addition, PAC requests the proponent to discuss closely with facility management to realize a smooth and efficient changeover from CDS to the Hyperon spectrometer at the K1.8BR beamline.

E70 (Cascade hypernuclei)

The E70 experiment will conduct the spectroscopy of $^{12}{}_{\Xi}$Be hypernuclei using the ^{12}C(K^-, K^+) reaction to examine the ΞN interaction. E70 will improve the missing-mass resolution to 2 MeV at FWHM, which is much better than those in the earlier experiments, BNL AGS-E885 and J-PARC E05, utilizing the newly commissioned S-2S spectrometer. A high statistics data set with good energy resolution should confirm the existence (or prove the non-existence) of a Ξ/ΛΛ bound state in ^{12}Be.

PAC congratulates the E70 group for its steady progress towards the physics run. During the pilot run in June 2023, they successfully checked the performances of all the new/existing detectors by online analyses and confirmed the offline analysis tools for the tracking performance in S-2S/K1.8 beam line. A big step forward is the improved resolution achieved with the active fiber target (AFT).

The introduction of machine learning into momentum analysis with the beam line spectrometer and the S-2S spectrometer is a promising technique that could achieve good momentum resolution with reduced analysis costs. However, since machine learning may black-box the analysis process, it cannot deny the possibility of unintended errors or issues in the analysis. Although the PAC believes that E70 is fully aware of this potential problem, the PAC recommends that E70 adequately prepares to validate the analysis by another method rather than relying solely on machine learning.

PAC gives the highest priority to E70 beam time at K1.8. The group requests the remaining 7.5 days commissioning/calibration run plus an extra 3 days of the beam time for physics run before the summer shutdown. In the physics run, they will collect 9400 Ξ production events, with which they check the validity of the event-by-event energy loss correction at AFT.

After the summer during the FY 2024, PAC endorses their request of 7 days (control run) plus 16.5 days (physics run) beam time. We also endorse an additional 1-day beam time for dedicated calibration run for E96.

E63 (Gamma-ray spectroscopy of light hypernuclei)

The original E63 comprises two physics measurements of gamma-ray spectroscopy from ${}^{4}_{\Lambda}H$ and ${}^{7}_{\Lambda}Li$ using a high-resolution gamma-ray detector, specifically the Germanium detector HyperBall-J. Initially, the proponent planned to conduct the experiment at the K1.1 beamline, with the SKS spectrometer. However, in this PAC meeting, the proponent requested to conduct a portion of the project, specifically gamma-ray spectroscopy on ${}^{4}_{\Lambda}H$, using the existing beamline and a scattered particle spectrometer, i.e., the K1.8 beamline and S-2S spectrometer.

The proponent requested two issues to be discussed in this PAC meeting. First, the endorsement of the E63 to conduct the experiment at K1.8 beamline with S-2S spectrometer. Second, for the realistic estimation of the physics beam time, the proponent requested a one-day test beam time before summer shutdown to obtain the operation parameters of the K1.8 beamline with 0.9 GeV/c beam momentum.

The E63 experiment has already received stage-2 approval in a past PAC meeting, where the physics motivation and the feasibility were thoroughly discussed and well-received by the PAC. In addition, the proponent presented a detailed comparison between the original plan and the revised proposal, including aspects such as beam intensity, spectrometer acceptance, and so forth. However, the most significant uncertainty for the project lies in the actual K^- yield with a 0.9 GeV/c beam momentum at the K1.8 beamline.

PAC recommends one-day beamtime for the beam turning of the K1.8 beamline with a 0.9 GeV/c beam momentum. The endorsement of the project to perform the experiment at the K1.8 beamline with the S-2S spectrometer will be discussed in the next PAC with the results of the one-day beamtime.

E73 (hypertriton lifetime)

The PAC congratulates the collaboration for the publication in Phys. Lett. B on the lifetime measurement of ${}^{4}_{\Lambda}H$ hypernucleus using in-flight reaction of ${}^{4}He$ (K^-, π^0) ${}^{4}_{\Lambda}H$, that demonstrated the feasibility of measuring the lifetime of ${}^{3}_{\Lambda}H$. The expected measurement accuracy is estimated to be 20 ps (stat) and 20 ps (syst) based on the data collected by the Stage-1 experiment in May 2021.

The PAC already recommended allocating 25 days of beam time at 80 kW for E73 before July 2024 at a high priority.

E80/P92 (Light Kaonic Nuclei)

E80 aims to study A=3 kaonic nuclei, K-ppn, produced via $K^- + {}^{4}He \rightarrow$ K-ppn + n reaction at K1.8BR beam line. Decay particles from kaonic nuclei will be measured using a new cylindrical detector system (CDS) which is under construction. In the present PAC meeting, E80 reported the construction status of the new CDS. Construction of the superconducting solenoid magnet, cylindrical drift chamber, and neutron counters will be completed in FY2024.

E80 also requested the PAC to endorse the upgrade of the K1.8BR beam line, which was proposed in the TDR submitted to the PAC34 meeting. Removal of the D5 magnet and shortening of the beam line will increase the K^- beam intensity by a factor of 1.4. E80 expects J-PARC to start the application process to get a radiation-safety approval to modify the K1.8BR beam line as early as possible because the process generally takes a long time. The PAC understands this situation. However, this issue is under the jurisdiction of the facility as the modification is strongly coupled with the other facilities in J-PARC. The PAC suggests E80 to continue discussion with the facility for upgrading the beam line. The PAC also expects that E80 will submit an updated TDR in accordance with the comments by FIFC to the next PAC meeting for receiving the stage-2 approval.

T98 (LArTPC)

The goals of T98 are to search for rare antideuteron capture and to characterize antiproton capture in a liquid argon TPC (LArTPC) using a charged-particle beam. The findings of T98 will be highly beneficial to the GRAMS project which is an astrophysical initiative that will study cosmic anti-matter with an airborne or spaceborne LArTPC.

We acknowledge the T98's success of carrying out Phase-1 that determined the yield of antideuterons with a momentum of 1.0 GeV/c in the K1.8BR beam line operating at 50 kW on 21 June 2023. T98 amassed deuterons identified by the time-of-flight counters in the beam line for calibration. Unfortunately, with two hours of the negative-beam setting, no antideuteron was found.

Based on the results of Phase-1, T98 proposed Phase-2 to acquire antiproton events with the LArTPC at K1.8BR. The plan is to study antiproton capture on argon with 0.65-GeV/c to 0.75-GeV/c, and 1.0-GeV/c antiprotons. The collaboration requests 24 hours of beam time in the fall of 2024. We note that this would allow analysis of the data prior to the next stage of the GRAMS program. The next balloon flight is scheduled in the fall of 2025 or spring of 2026, and its funding has been secured already.

Since no antiproton capture on argon has ever been observed before, the findings of Phase-2 will be valuable to GRAMS and the scientific community at large. We thus recommend approval of Phase-2 to T98 for 24 hours of beam time in the fall of 2024.

P95

The interaction of the meson and the nucleon is of special interest, as ϕ is a meson containing only the strange quarks, made of $s\bar{s}$. The OZI rule indicates strong suppression of meson exchanges and thus predicts a weak interaction, while the femto-scopy at high-energy collider experiments as well as lattice QCD analyses suggest a significant attraction between ϕ and N. It is therefore interesting and important to study the ϕ-N interaction in various production channels and energies in detail. P95 proposes to measure the cross-section of the pion-induced production of ϕ on the proton, $\pi^- p \rightarrow \phi n$, focusing on an s-channel ϕ-N resonance, N*, around 2.2 GeV in the center-of-mass energy. It is motivated by a bump structure observed in the photo-production, $\gamma p \rightarrow \phi p$, at this energy region. The $\pi^- p \rightarrow \phi n$ reaction is dominated by the s-channel interaction and thus is more sensitive to the ϕN resonance than the photo-production.

P95 submitted the addendum2 in response to the concerns raised in PAC35. P95 has invited theorists to the collaboration to reinforce the analysis of the experimental data from the viewpoints of hadron reaction and spectroscopy. The proponent has demonstrated that the proposed momentum bin is capable of pinning down a narrow resonance at this energy region. A required secondary beam line of negative-pion is under discussion at the P93 task force in INPS.

Despite the development presented at the PAC37 meeting, the PAC considers that what physics we learn from the peak search is not clear enough. If the peak is not observed, what kind of limits can it give to physics models? If the peak is observed, what is the following steps to understand the underlining physics? The PAC considers that those strategies should be clearer. PAC appreciates P95 for inviting theorists who may propose various possible origins of the resonance. However, it is not clear how P95 proceeds to distinguish different models and determine the resonance properties, even if they confirm the resonance. The proponent indeed realizes it and suggests further measurements, such as $\gamma d \rightarrow \phi pn$, $K^*\Sigma N$, $K\Sigma^*N$, after establishing the peak. PAC asks the proponents for additional information to clarify their physics goal, the role of the proposed experiment and the paths towards the goal with the help of the theorists.

P102

P102 is motivated by a narrow bump structure at 1680 MeV/c^2 in the mass spectra measured by the $\gamma n \rightarrow \eta n$ reaction. This structure is not observed in the $\gamma p \rightarrow \eta p$ reaction, and might be due to a five-quark state. P102 proposes a new measurement of the total and differential cross sections of the $\pi^- p \rightarrow \eta n$ reaction using a CsI(Tl) calorimeter, which detects decay γ rays from η mesons.

The PAC is not currently convinced of the scientific perspective discussed in this proposal. As the proponents noted, this structure was not observed in the old measurements of the $\pi^- p \rightarrow \eta n$ reaction. The discovery of this state in a new measurement is challenging because the density of the existing data points between p_π = 950–1100 MeV/c seems to be high enough to observe the state as shown in Fig. 9 of Nucl. Phys. B 153, 89 (1979). P102 should clarify the advantages of the proposed measurement over the old measurements for validating this challenging measurement. It is also essential to explain how P102 elucidates the nature of the bump observed in the $\gamma n \rightarrow \eta n$ reaction. The spin and parity are crucial to clarify the structure of this uncertain state although P102 is not fully prepared to determine these quantum numbers. Comparative studies with the electromagnetic and hadronic probes might provide insights into it as well, but this aspect has not been discussed yet.

The PAC also notes that the experimental consideration of P102 is still immature. The CsI(Tl) calorimeter is not fully optimized for the proposed measurement. Large holes in its barrel part could distort the measured mass spectrum of the eta meson and decrease the detection efficiency. The PAC suggests that P102 consider compensating for the holes or using other calorimeters such as BGOegg or FOREST. In addition, P102 should conduct more realistic simulations that incorporates backgrounds from neutrons or charged particles other than γ rays before the measurement.

P99 (Epithermal Neutrons)

P99 seeks to study fundamental symmetries in the interactions of epithermal neutrons with nuclei, in particular it will search for time-reversal invariance violation (TRIV). Fundamental TRIV, or equivalently CP violation, can potentially lead to the emergence of Electric Dipole Moments (EDMs) at low-energy scales in composite systems. The search for TRIV is an efficient method to search for new physics beyond the present Standard Model of elementary particles.

Parity violation (PV) and TRIV are understood to be significantly enhanced in the vicinity of the p-wave of neutrons propagating through polarized nuclei. The proposal focuses on the 0.75 eV p-wave resonance state of ^{139}La+n, where largely enhanced parity violation has been observed.

The proponents addressed the following questions from PAC36 by providing detailed descriptions and explanations.

(i) What is the largest signal expected in NOPTREX, given the current bounds on the neutron and 199Hg EDMs?

(ii) In what sense is this experiment complementary to neutron and diamagnetic atom EDM searches? Can this be made concrete through a multi-dimensional analysis in terms of effective CP-violating couplings?

(iii) What is the impact of theoretical uncertainties in the neutron-nucleus matrix elements of the P- and CP-violating interactions?

(iv) What is the expected signal if the only source of CP violation is the Kobayashi-Maskawa phase in the Standard Model?

All the theoretical questions above were answered in the provided documents and the presentation. However, although the sources of systematic errors are listed in the proposal, quantitative estimates of the systematic errors are missing. The PAC asks the proponents to study the size of systematic errors by running realistic Monte Carlo simulations or by some other way.

The proponents presented conceptual sketches of the experiment and have decided on $LaAlO_3$ as target material. To judge technical feasibility of some key techniques and the readiness of the experiment, PAC recommends setting up an external panel and expects a report at the next PAC meeting.

P100 (Pulsed Cold Neutrons)

The original P100 proposal, initially covering a large variety of experiments with pulsed neutron beams, has been considerably reduced, now focuses selectively on measurements of the neutron lifetime. The formerly included investigations on neutron interferometer, short-range gravity search, R&D for nEDM experiments will be addressed in the framework of the MLF general use proposals. The PAC supports explicitly narrowing the focus to a specific topic.

The proposed experiment will determine the neutron lifetime with an unprecedented, highly improved precision, quite rightly called a flagship experiment. The successful measurement will resolve the longstanding, rather disturbing uncertainty about a fundamental datum of nuclear and particle physics. A conclusive answer can be expected on the still open question, whether the existing discrepancies and partly conflicting results are due to some hitherto unidentified systematic experimental errors or if they indeed indicate new physics beyond the standard model.

The PAC congratulates the P100 collaboration for the recent progress achieved for the preparation and optimization of the neutron lifetime measurements by addressing the clarifications which were requested by PAC36. The systematic errors of the former experiments using beam methods and trapped neutrons have been critically scrutinized, including also the neutron detection efficiency. The PAC recognizes the special demands on a high precision experiment and considers the achievements as important steps to identify other sources of disturbances hidden in the complexity of the experimental setup.

The PAC agrees that the proposed method is a promising approach to measure independently the neutron lifetime, free of the limitations and systematic uncertainties inherent to the competing former experimental method. However, further investigations are required to demonstrate that the sensitivity can be reduced down to the critical 1 s level as proposed. A highly interesting and important issue is to further improve the understanding of the background.

The PAC encourages continuation of the project and welcomes the upcoming commissioning experiment. However, before approval we find it necessary to investigate further the background problem, posing a potential hazard for the success of the project. The discrepancy between observations and Monte Carlo simulations might hint at yet to be identified systematic errors of the setup. The isotopic abundances in natural Li (about 8% ^{6}Li and 92% ^{7}Li) and the related differences in the nuclear level structure may play a role. Also, other issues mentioned in the presentation, such as neutron–gas and possibly also electron-gas interactions, need to be understood. An important part of the overall uncertainties is the pile-up problem which also needs further investigations and clarification whether a substantial reduction is indeed achievable, and if so, to what level. The PAC is looking forward to an updated proposal.

E14 (KOTO)

The KOTO experiment (E14) searches for the rare CP-violating decay $K_L \rightarrow \pi^0 \nu \bar{\nu}$ in the J-PARC neutral beam line. The decay rate is precisely predicted and thus provides an excellent probe for physics beyond the standard model. KOTO recently presented a limit on the branching fraction of 2×10^{-9} at the 90% C.L. from their 2021 run based on the observation of zero signal candidates upon an estimated background of 0.255±0.058(stat)+0.053-0.068(syst) events. At this meeting, KOTO also reported on analysis of data taken in 2023 as well as upgrade work.

The latest result has benefitted from the systematic and methodical approach to investigate and estimate each background component, incremental detector improvements, and improved signal discrimination. Data-driven corrections have improved the estimates of the background from $K_{2\pi}$ ($K_L \rightarrow \pi^0\pi^0$) decay and upstream π^0 production. $K_{3\pi}$ ($K_L \rightarrow \pi^0\pi^0\pi^0$) decays with 5 γ's detected in the CsI calorimeter determine the 6th γ's kinematics which can be used to measure the veto inefficiency. The statistical uncertainty from the size of this $K_{3\pi}$ sample dominates the overall systematic uncertainty in the background estimate.

KOTO used limited beam time in June 2023 to confirm the expected >99% efficiency of their new upstream charged veto (UCV) and to evaluate the performance of a new DAQ system. The new DAQ took data stably at an event rate of 15k/spill but exhibited losses at higher rates. Tests of further DAQ upgrades at U. Chicago have been completed and will be deployed in March for the next beam exposure. Acquisition rates of ~30k/spill are needed to accumulate sufficient statistics to accurately determine the veto inefficiency with $K_{3\pi}$ decays. The beam time in June 2023 was insufficient to study and improve the time structure of the beam, which is suspected as one of the limits of the DAQ.

A moveable permanent magnet was installed at the end of the neutral beam line in 2023. While this magnet should reduce the K^+ flux by an order of magnitude, the neutron and K_L halo is expected to increase slightly due to the collimation changes. At least one month of data at 80 kW before summer is requested to understand the effects of the new magnet and UCV, improve the time structure of the beam and evaluate the performance of the DAQ. KOTO also requests 3 months of running every year for 4 years to reach a sensitivity $< 10^{-10}$.

The PAC commends KOTO on the continuing evolution of their analysis methodology and techniques that have resulted in the improved limit on the branching fraction from the 2021 data. This improves the prominence of rare kaon physics in the community and bodes well for KOTO in the future. It is important that KOTO has regular beam time so they can continue their stepwise improvements in sensitivity. The PAC fully endorses KOTO's request for beam time.

E11/E65 (T2K)

T2K is a long-baseline neutrino experiment consisting of a high-power neutrino beam and suite of near detectors at J-PARC and the Super-Kamiokande detector 295 km away in Kamioka. The committee heard about substantial progress on both analysis of previously taken data and upgrades to the beam and detector for future data taking. On the analysis side, a major focus has been on combined fits of T2K data with other experiments, with significant progress being made in both T2K+SuperK and T2K+NOvA joint fits. T2K is also expanding its efforts to test the three-flavor oscillation paradigm with new projections of PMNS matrix elements.

On the hardware side, the experiment reported that the beamline is on schedule with expected power increases and has operated stably above 700 kW for the first time and at 320 kA horn current. Progress has been made on upgrading the ND280 near detector, including first operation of the SuperFGD (with incomplete electronics), the bottom half of the HA TPC, and 4 out of 6 ToF modules. The full upgrade is expected to be complete by June 2024.

The experiment also reported on a concerning situation involving the far detector. After stable operations for many years, there were recently three separate incidents where coils that compensate for the Earth's magnetic field suddenly increased in resistance. This resulted in portions of the coils having to be turned off. Data taken with these coils turned off is still usable, but analysis will be more challenging. Future runs and calibrations are planned to mitigate the impact of having these (and potentially more) coils turned off.

The committee congratulates the T2K collaboration on impressive progress on both analysis and beam/detector upgrades. We recommend that T2K receive 27 days of beam in February/March 2024 and additional beam time of at least one cycle prior to the summer shutdown. We also recommend T2K receive at least 1.7 cycles after the summer shutdown, as discussed in the management comments. We look forward to hearing more from the collaboration this summer, including progress on commissioning the new near detectors. We would also like to hear about the status of the far detector coils and their impact on T2K data analysis.

E21 (COMET)

The COMET experiment is designed to search for a muon converting into an electron without emitting any neutrino inside an aluminum target at a new beam line (C-line) in the Hadron Hall. The overall strategy involves two phases: Phase-I, targeting a conversion rate of 10^{-14} with beam power of 3.2 kW, and Phase-II, aiming for the rate of less than 10^{-16} with 56 kW.

The engineering run (Phase-α) was conducted in early 2023 without the pion capture solenoid. Beam position profile was successfully measured by the muon beam monitor in coincidence with the range counter. The counting rates obtained from the data and simulation agree well across various degrader thicknesses and detector positions. Notably, non-negligible counting rate from outside the proton beam target was identified and understood. In November 2023, a test beam run was carried out at PSI to measure the efficiency of the range counter and the results were incorporated into the Phase-α analysis. Additionally, a cylindrical triggering hodoscope was tested with electrons/muons/pions, confirming a good electron/muon separation. Timing resolutions were well below the target of 1 ns, even for small charge deposits. Despite receiving only half of the allocated beam time, the system functionality was well confirmed. In December, the slow extraction and 8-GeV beam times in JFY2023 were canceled. To start the physics data taking of Phase I as soon as possible, the collaboration decided to cancel Phase-α, and to focus on the preparation and robust planning for Phase I. Progress on the proton beam target, infrastructure, and each detector component were reported. The analysis software is transitioning from a development phase to production cycles. Despite the geopolitical issue, the JINR has successfully transferred the first cosmic-ray veto module to KEK via the Republic of Georgia. This crucial component, which arrived at the end of last year after a long procedural hurdle, marks a positive first step toward the completion of the veto system by JINR.

To ensure that the startup of Phase I is on schedule, the collaboration is considering reducing the initial beam power and use less shielding as a means to lower the costs. A strategy to minimize risks associated with the solenoid is also considered. Discussions are underway to enhance the management structure for better coordination and faster decision-making.

The PAC congratulates the collaboration on the successful engineering run, acknowledging all the efforts and dedicated studies in overcoming challenges. We encourage COMET to continue their efforts for further progress towards the timely realization of Phase I and II.

E34 (g-2, EDM)

E34 aims to perform precise measurements of the anomalous magnetic moment and electric dipole moment of the muon with a novel technique utilizing a cold surface-muon beam, muon acceleration and injection into a compact storage magnet, at J-PARC MLF H-line. Recent developments in this field are the results released by FNAL and CMD3 experiments in 2023, and updates on Lattice QCD calculations. The hint of discrepancy between experiments and theory remains.

The PAC welcomes the news of the funding for the g-2/EDM experiment at J-PARC being included in the MEXT budget for FY2024, which will allow the completion of the extension of the H-Line to the H2 area. An IPNS Progress Review Committee follows the progress of E34, with annual meetings. A first report was produced in April 2023, including a set of recommendations, to which E34 has responded in August 2023. The collaboration is working on the recommendations and the second review meeting will be held in March 2024.

Because of the fire accident and a vacuum problem in 2023, the 80KeV acceleration to S2 and the completion of the electron injection test have been postponed to 2024. In the meeting, a summary of the progress in the facility construction, the muon source, the LINAC cavities, the injection system, and the storage magnet were reported. The final engineering design of the building and facility are to be completed by March 2024. The 80keV acceleration system at S2 is ready, and the injection test with electrons will be completed in FY2024. Developments of the positron detector, the DAQ and computing system, and software and simulation were also presented. A new working group has been formed, to provide feedback on the final experimental design and to accelerate physics studies and evaluation of systematic uncertainties.

The PAC acknowledges the steady progress of E34 on many fronts since the last meeting, and is looking forward to the next update at PAC38.

E56/E82 (JSNS^2, JSNS^2-II)

JSNS^2 uses muon antineutrinos coming from muon decay at rest to search for light-mass sterile neutrinos by detecting the appearance of electron antineutrinos via the inverse beta-decay reaction with two detectors filled with gadolinium-doped liquid scintillator at MLF.

In Phase-1 of JSNS^2 (E56), the experiment utilized only the near detector with the baseline of 24 m and has acquired data with 3.28×10^{22} POT, which is 29% of the approved POT. We have learned that a new calibration system with ^{252}Cf was realized for energy and vertex calibration throughout most of the active volume. In addition, the PAC heard the status of the ongoing analysis using the blinding approach. The experiment has been focusing on understanding the background in only one of the side-band regions. We encourage the JSNS^2 collaboration to extend the study to all side-band regions. We congratulate the JSNS^2 collaboration on publishing their methodology for addressing the accidental background and getting ready to draft manuscripts reporting on the pulse-shape discrimination technique for rejecting the fast-neutron background and on calibration with ^{252}Cf.

In Phase-2 of JSNS^2 (E82), a far detector at 48 m from the antineutrino source is being installed. We were pleased to hear that the construction of the far detector and facility is proceeding well and almost finished. New Hamamatsu photomultiplier tubes for the veto region are expected to arrive and be installed towards the end of March 2024. The critical item is the installation of the AC power lines from MLF to the far site which is still under safety review. Commissioning of E82 is expected to begin before the 2024 summer shutdown. The PAC congratulates JSNS^2 on the good progress.

Since the findings of the experiment will attract much attention in the community, the PAC strongly recommends the JSNS^2 collaboration to present more details of their analysis, including their strategy for unblinding the signal region, in the upcoming PAC meeting.

E71 (NINJA)

The NINJA experiment is aiming to measure the differential cross sections of charged-current neutrino interactions. Precise cross section measurements are crucial to neutrino physics research, as they mitigate systematic uncertainties due to modeling neutrino interactions with atomic nuclei. The advantage of using emulsion is the capability of measuring low energy secondary particles which may not be visible in other detectors, including protons, pions, gammas and leptons with good particle identification.

The NINJA collaborators have already collected data with test experiments (T60, T66, T68 and T81) and presented physics results in several publications. The collaborators successfully took experimental data (E71a) from Nov. 2019 to Feb. 2020 with a total number of protons on target of 4.8×10^{20}. The experiment used a 250 kg target mass containing water and iron as well as emulsion sheets. Neutrino interaction events are recorded in the emulsion sheet with the timing and position information obtained with the emulsion shifter and the scintillation tracker as well as the muon tracker (BabyMIND). The collaboration has opened all the E71a data and is conducting careful data analysis. The results will be public soon. The PAC is looking forward to hearing the results in the next meeting.

The PAC congratulates NINJA on the successful preparation for E71b that employs a new emulsion facility and emulsion films to collect 5.2×10^{20} POT in total. The PAC acknowledges possible future plans including the change of the target from iron to lead, placement of ECCs (Emulsion Cloud Chambers) in front of the INGRID for water and heavy water, and installation of a large number of ECCs for the measurements of neutrino interaction cross section in the energy range of 200-400 MeV. The PAC also acknowledges that the conveners are assigned for the T2K-NINJA joint working group to discuss the incorporation of E71's output to T2K neutrino oscillation analysis and data sharing.

4. GENERAL REMARKS AND RECOMMENDATIONS

The PAC would like to congratulate J-PARC on the successful operation of Main Ring (MR) after the major upgrade. In particular, the continuous fast extraction (FX) running at 760 kW is a major step towards increasing the sensitivity for T2K and for HyperK neutrino experiments. Also, facilities have recovered from the fire incidents in a timely manner with many preventive measures applied. The PAC recognizes that all these accomplishments would not have been possible without the hard work of J-PARC and KEK staff members at all levels.

For the facility side, the PAC considers that the priorities are to:

1. establish stable operation of the MR,
2. increase the beam power for both FX and slow extraction (SX),
3. improve the spill structure for SX, and
4. secure longer beam time.

One of the mandates given by the Director was to prioritize experiments. The scheduled beam time presented at the PAC is 27 days in February - March 2024, 26 days in April - June 2024, and 71.5 days from November 2024 till March 2025.

Considering the priorities set at the previous PAC meetings, requests from experiments, and conditions explained at the meeting, the PAC recommends the following in order of priority.

February - March 2024:

1. FX for neutrino experiments (27 days)
2. SX to MR abort for studies

Before the summer shutdown:

1. SX run

    E70 at K1.8 (7.5 days for S2S commissioning)

    B-only mode beam time (1.75 days)

    E16 A+B mode (7.5 days)

    E73 at K1.8BR (25 days)

    E70 at K1.8 (3 days physics)

    E72 beam test at K1.8BR (4 hours)

    E63 at K1.8 (1 day)

    KOTO should run concurrently with K1.8BR and K1.8 running.

2. FX for neutrino experiments (at least 1 cycle) before the summer shutdown for maintenance.

3. Accelerator studies to establish stable high-intensity operations, because it has large impacts on future runs.

After the summer shutdown, 71.5 days (3.25 cycles) is currently planned in FY2025. FX is requesting more than 88 days (4 cycles), and the sum of SX requests ranges from 32.5 days to 64.5 days. Although a long beam time for T2K is extremely important to keep it competitive with NOvA, some experiments in Hadron Hall should be finished to let other pending experiments start.

The PAC thus recommends the following:

1. 38 days (1.7 cycles) to T2K.

2. 33 days (1.5 cycles) to Hadron Hall experiments to finish E70, E75, and T98, and to increase the sensitivity of KOTO.

The PAC strongly encourages the management to allocate more beam time. Additional beam time will allow studies for stable high-intensity MR operations, and higher sensitivities for T2K and KOTO. If both E63 and E72 are ready to run by March 2025, they could use the extra beam time by starting earlier. The priorities for such additional beam time will be discussed in the next PAC meeting if needed.

The new chair would like to thank Rik Yoshida for his excellent management and all the tools he had developed during the pandemic that improved the efficiency of the reviewing and reporting processes. Those tools are useful even after the pandemic, and they will be prepared by the secretariat from now on.

5. DATES FOR THE NEXT J-PARC PAC MEETING

The next J-PARC PAC meeting will be held around the end of July, 2024.

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

- Minutes of the 36th J-PARC PAC meeting held on 19-21 July 2023 (KEK/J-PARC-PAC 2023-11)
- Proposals:
    - Measurement of neutrino-induced neutron and γ-ray background for BGO-based detectors at J-PARC (KEK/J-PARC-PAC 2024-1)
    - Study of the peculiar bump structure at 1680 MeV by the $\pi^- p \rightarrow \eta n$ reaction with momenta of $p_\pi = 0.85$-1.2 GeV/c (KEK/J-PARC-PAC 2024-4)
- Report:
    - Report on T98 (Measurement of Anti-Matter Reaction in LArTPC) and Phase-2 Request (KEK/J-PARC-PAC 2024-2)
    - Pion-induced phi-meson production on the proton (addendum 2) (KEK/J-PARC-PAC 2024-3)
    - Study of Discrete Symmetries in Polarized Epithermal Neutron Optics (NOPTREX: Neutron Optical Parity and Time-Reversal Experiment)
    - P100 Fundamental Physics with Pulsed Cold Neutrons

- Revised plan of J-PARC E63 experiment “Gamma-ray spectroscopy of Light Λ Hypernuclei II”