KEK/J-PARC-PAC 2022-23
October 12, 2022

J-PARC Program Advisory Committee

for the Nuclear and Particle Physics Experiments

at the J-PARC Main Ring

Minutes of the 34th meeting held
3(Wed.)-5(Fri.) August, 2022

OPEN SESSION:

1.	Welcome and J-PARC Center Report:	T. Kobayashi (J-PARC/KEK)
2.	J-PARC Accelerator Status & Plan:	S. Igarashi (J-PARC/KEK)
3.	Mandate to the Committee:	N. Saito (KEK)
4.	T2K analysis:	C. Bronner (Tokyo)
5.	T2K hardware & beam request:	T. Sekiguchi (J-PARC/KEK)
6.	E56/E82(JSNS2):	T. Maruyama (J-PARC/KEK)
7.	Hadron Facility Status & Plan:	H. Takahashi (J-PARC/KEK)
8.	E14(KOTO):	T. Nomura (J-PARC/KEK)
9.	E21(COMET):	S. Mihara (J-PARC/KEK)
10.	E70 Ξ hypernuclear spectroscopy:	T. Gogami (Kyoto)
11.	E75 Measurement of the formation cross section $^{7}_{\Xi}$He in the ^{7}Li(K^-, K+) reaction:	H. Fujioka (Titek)
12.	E34(g-2/EDM):	T. Mibe (J-PARC/KEK)
13.	E71(NINJA) :	T. Fukuda (Nagoya)
14.	E73 Lifetime measurement of $^{3}_{\Lambda}$H:	Y. Ma (RIKEN)
15.	Hadron Hall Extension - Future plan and HEF:	T. Takahashi (J-PARC/KEK)

16. P86 Measurement of the differential cross section and spin observables of the Λp scattering with a polarized Λ beam: K. Miwa (Tohoku)

17. P93 Test experiment to evaluate performances of secondary beam mode at the high-momentum beam line: K. Shirotori (RCPN-Osaka)

18. P94 New generation Λ hypernuclear spectroscopy with the (π^+, K^+) reaction by S-2S: T. Gogami (Kyoto)

19. P95 Pion induced phi-meson production on proton:
T. Ishikawa (ELPH Tohoku)

20. P96 Measurement of X rays from Ξ-C atom with an active fiber target system:
T. Yamamoto (JAEA ASRC)

21. E31 Spectroscopic study of hyperon resonances below KN threshold via the (K^-, n) reaction on Deuteron: H. Noumi (RCNP-Osaka)

22. FIFC report: S.Uno (KEK)

23. E16 Measurement of Spectral Change of Vector Mesons in Nuclei:
S. Yokkaichi (RIKEN)

24. E80/P92 Systematic Investigation of the Light Kaonic Nuclei:
F. Sakuma (RIKEN)

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

26. Beam Time Schedule in 2022 T. Komatsubara (J-PARC/KEK)

CLOSED SESSION:

Present: P. Achenbach (Mainz), I. Adachi (KEK), M. Blanke (KIT),
V. Cirigliano (Washington), M. Endo (KEK), L. Fields (FNAL),
H. Ishino (Okayama), Y. Itow (Nagoya), D. Jaffe (BNL),
K. Joo (Connecticut), T. Kawabata (Osaka), C. Lazzeroni (Birmingham),

F. Le Diberder (LAL), H. Lenske (Giessen), K. Luk (Berkeley),

K. Miyabayashi (Nara), A. Ohnishi (TITP-Kyoto), H. Ohnishi (Tohoku),

M. Oka (JAEA), A. W. Thomas (Adelaide), N. Xu (LBNL),

K. Yorita (Waseda), R. Yoshida (Chair, Argonne),

N. Saito (KEK-IPNS Director),

T. Komatsubara (KEK-IPNS Deputy Director) and

T. Kobayashi (J-PARC Director)

1. PROCEDURAL REPORT

The minutes of the 33rd J-PARC-PAC meeting (KEK/J-PARC-PAC 2022-15) 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, introduced the organizational chart of J-PARC. He reported the beam power history at MLF and showed that the 800kW stable operation was achieved. In addition, he showed that the completion of a new muon H1-line and its start-up had begun. He also reported the completion of the MR power supply installation this March. He explained that the test operation and tuning of the MR power supply started in April and the beam circulation succeeded in the 3 GeV operation before the summer shutdown.

Kobayashi explained the budget of JFY2022 situations both for JAEA and KEK, which includes the cost of the 7.2-cycle operation of RCS/MLF. On the KEK side, it includes costs for the 4.5-cycles of MR operation, MR beam power upgrade, and J-PARC facility upgrade for the Hyper-Kamiokande project. Kobayashi also explained that the budget request of JFY2023 includes 6.5-cycle operation, beam power upgrade, g-2/EDM facility construction, polarized-neutron beamline/muon H-line construction, and facility upgrade for Hyper-Kamiokande. He showed a plan to reduce LI/RCS/MLF operation period because of the recent situation of the skyrocketing electricity price.

Kobayashi introduced that the KEK Project Implementation Plan (PIP) was released in June considering the KEK scientific advisory committee (SAC) recommendations. He explained that the PIP report describes the initiation of g-2/EDM facility construction and completion of COMET Phase -I facility construction to be realized by J-PARC machine operating budget in addition to MR operation for six months. He outlined the prioritization the PIP funding requests. This list includes the extension of the J-PARC Hadron Experimental Facility and Transmission Muon Microscope as J-PARC projects.

Kobayashi mentioned that in recent years the approval process for Radio Isotope facility modification by NRA (Nuclear Regulation Authority of Japan) takes longer (> 6 months) than previous cases of nominal 3 months. The current application to NRA was submitted in Feb. but has not been approved yet.

Kobayashi showed the COVID situation at J-PARC. He explained that in JFY2021 and 2022 beam operation has not been affected much by the COVID pandemic and users are allowed to visit J-PARC with careful countermeasures. Before summarizing his presentation Kobayashi showed the construction plan and its progress of the J-PARC access road. Direct access to the J-PARC site is long awaited from user communities. He reported that the detailed design will complete in JFY2022 to be ready for construction. In the last, Kobayashi introduced the outreach events related to J-PARC.

2-2 J-PARC Accelerator Status (Susumu Igarashi, J-PARC/KEK)

Susumu Igarashi reported the status of J-PARC accelerator. He explained the beam operation summary of MR; from March to April in 2021 the beam power of 510kW was achieved in FX operation. In May to June in 2021 SX 30GeV operation was successfully conducted at 64.5kW with an extraction efficiency of 99.5%. After that MR was shut down for realizing faster beam operation cycle of 1.36-s instead of 2.48-s in FX operation. To this end they have been upgrading the following hardware, magnet power supplies, RF system, injection and extraction devices, and collimators.

The magnet power supply system is now composed of newly installed power supplies and reused ones. Both types must be tuned for the operations of 1.36-s, 2.48-s and 5.2-s cycles. It is also necessary to prepare 9.6-s cycle operation for 8 GeV beam extraction, which will be realized by repeating 4.8-s pattern operation. They will complete tuning of both newly installed power supplies and reused power supplies after summer. To realize faster cycling operation of the MR the RF system needs to be upgraded to achieve higher voltage; nine fundamental cavities and two 2^{nd}-harmonic cavities are necessary for 1.36-

s operation. Eight fundamental cavities and two 2nd-harmonic cavities will be available in the MR operation after summer 2022. The extraction system also needs upgrade for faster cycling. The system is composed of kicker magnets, low-field septum magnets, and high-field septum magnets. Kicker operation at 1Hz has already been confirmed. All septum magnets are replaced. However, the accelerator group has found a water leak in the coil of SM32, one of the high-field septum magnets. New coils for SM32 will be fabricated for both neutrino side and abort side. The neutrino-side coil will be replaced in the summer shutdown of 2022 and the abort-side coil will be replaced in summer 2023. As for the collimator system, one collimator is newly installed in summer 2022, resulting in seven collimating points in total in the MR.

Finally, Igarashi summarized his presentation by showing the MR study plan as well as user operation after the shutdown in 2022. They will start study operation in FX and SX mode along with user operation so that the beam transport tuning can be carried out in an efficient manner. User operation for physics data acquisition is expected in JFY 2023 if the operation budget is secured

2-3 Hadron Facility Status and Plan (Hitoshi Takahashi, J-PARC/KEK)

Hitoshi Takahashi reported the status and plan of the construction work as well as the maintenance work during the long shutdown. In the K1.8 area, the previously used spectrometer, KURAMA was replaced with a new spectrometer, S-2S. Construction of the new primary beam line for the COMET (C-line) completed last JFY. Preparation of the COMET phase-α is now underway in the Hadron South building. Maintenance of the upstream part of secondary beam lines are also underway in the Hadron Experimental Hall. The upstream slits in the K1.8 and K1.1 beam lines are maintained due to the end of life of the potentiometers. The D2 magnet in the K1.1 beam line was uninstalled to investigate the cause of the degradation of the coil insulation and to repair it if possible. The work is now underway. Maintenance work will complete, and the Hadron facility will be ready for beam by the middle of next December. However the maintenance work schedule may change if the next SX beam time is delayed.

Takahashi also presented the development status of the secondary-beam production target. The current target is made of a gold block indirectly cooled by water, and capable of accepting the beam up to 95kW for 5.2-s spill cycle. In order to increase the beam power over 100kW, they are developing a rotating disk target directly cooled by He gas. To improve the efficiency of He-gas cooling and to increase the lifetime of bearings, a

gas bearing is under development. A new test bench with a dummy disk made of Cu and W alloy is prepared for testing the gas bearing rotation. The first rotation test was successfully carried out over 500 rpm. An impulse hammer test was also performed to check the stability of the gas bearing system, and the measured resonance frequency was found to be consistent with the calculation. They will proceed further tests of the rotation system as well as the other related R&D items, such as a He compressor and target monitors in this JFY. Integration of all designs of the rotation target is anticipated in the next JFY.

2-4 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 reported on the renewal of the committee membership of the Program Advisory Committee for the Nuclear and Particle Physics Experiment at J-PARC Main Ring (MR). Seven members out of sixteen are replaced. He noted that this PAC meeting is held with participation of the previous and new members. He introduced the IPNS organization partially revised this fiscal year. He also introduced recent progresses of projects under the IPNS.

An update on the latest situation of the KEK Roadmap 2021 and Project Implementation Plan (PIP) 2022 is explained. As it was also reported in the 33rd PAC, the KEK Roadmap 2021 has been published on May 31, 2021 and reflected the KEK Scientific Advisory Committee (SAC)'s recommendations. The PIP 2022 has been established as a prioritized list for budget request for the next 5 to 6 years after the SAC's review. The SAC recommended the hadron experimental facility extension as the highest priority. There are remaining projects to be implemented from the previous PIP (PIP 2016), the MLF muon beam H-line and g-2/EDM experiment.

Saito mentioned the timeline of projects under the IPNS. The Hyper-K project construction including the J-PARC beam upgrade will complete by JFY 2027 and the Hadron Experimental Facility extension will be conducted around 2025-2027. He also mentioned several challenges. One of them is to take a balance between the beam time and facility improvements. The beam time should be priority after the long shutdown of J-PARC MR power supply upgrade. Securing the beam time under oil price skyrocketing and thus, paying the electricity bill is another challenge.

There are two technical design reports (TDRs) from E16 and E80/P92 as well as the FIFC report submitted to the PAC34. There are also three new proposals and one revised proposal submitted. Another proposal for an experiment at MLF was also submitted but it does not require any resources from the IPNS. As such, it is under discussion with IMSS and J-PARC how to evaluate this proposal. The feasibility of the P93 beamline modification part is mentioned. The proponents of the P93 and the laboratory/facility discussed the technical feasibility, necessary resources, and schedule. Based on the discussion, it is clarified that starting P93 at the B-line before the summer shutdown of 2023 is difficult.

Saito requested the PAC to evaluate the new proposals as well as requests for stage-1 status and stage-2 approval, and to provide recommendations to the IPNS and J-PARC directors. He also requested to assess the progress of ongoing experiments along with any advice on the run plan after the long shutdown.

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

E11/65 (T2K/T2K2)

E11/65 (T2K/T2K II) is a long-baseline neutrino oscillation experiment with the primary goals of exploring CP symmetry, resolving the mass hierarchy and the octant of the mixing angle θ_{23}. The experiment utilizes the Super-K detector as the far detector for studying neutrino oscillation. The near detectors, INGRID, ND280 and WAGASCI, located at J-PARC are used for characterizing the neutrino beam and measuring neutrino interaction cross sections.

We congratulate the T2K collaboration on the impressive progress made in analysis since the last PAC meeting. They succeeded in increasing the amount of data, reducing systematic uncertainties in modeling the beam flux and neutrino-nucleus interaction, and improving analysis techniques. The use of multi-ring events observed with the Super-K detector that has led to an increase of muon-like events in the neutrino mode by 30% for the T2K oscillation analysis is impressive. We look forward to hearing progress of the analysis of the Run 11 sample with Super-K loaded with gadolinium and WAGASCI in operation. T2K reported that having four more cycles of data collected with a beam power

of 750 kW running in the neutrino mode and a higher horn current will improve the reach of searching for CP violation over what has been published.

The PAC continues to encourage T2K to carry out joint analyses with Super-K, NOvA, and NINJA. Experience from the T2K-NOvA joint analysis shows that significant time and effort are required to realize the goals. Prior to the establishment of a T2K-NINJA joint analysis, we encourage T2K to communicate to NINJA the format and content of a NINJA data release, including modeling details, that could facilitate their use by T2K (and other experiments).

We learned that the upgrades/improvements to the various elements of the neutrino beamline will be finished by December 2022.

The status of the upgrade of ND280 was also presented. They suffer from a supply-chain problem in the production of the high-angle TPC (HATPC) field cage, which becomes a critical path in the ND280 schedule. Super FGD (SFGD) and the first HATPC are expected to be ready for installation by March 2023. Installation of SFGD with the bottom HATPC together minimizes the risk of lifting the SGFD. Initial installation without the HATPC entails three lifts of SFGD. Useful data can be acquired with SFGD-only running. The collaboration has made contingent plans to complete the ND280 upgrade considering the risk assessment of SGFD lifting and HATPC availability. Optimistically, a decision can be reached in February 2023. The second HATPC won't be ready until the summer of 2023. It appears that COVID-19 and geopolitical issues could still pose some risk to the schedule.

We heard the success of dissolving more gadolinium in the Super-K detector to reach a Gd concentration of 0.03%. The detector is expected to be ready for receiving the neutrino beam by the middle of November 2022.

We note that T2K has requested 3 cycles of data taking before the summer of 2023 and 3 more cycles with the upgraded ND280 between October 2023 and March 2024, in order to help T2K to remain competitive with NOvA.

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

E56/JSNS^2 is a single-detector sterile neutrino search experiment at the MLF intended to be a direct test of the LSND anomaly. They completed a second long physics run in

May 2022. A blinded search for sterile neutrinos is underway now. Four sidebands and a signal region have been identified in the two-dimensional space of prompt IBD candidate energy and delayed IBD candidate energy. The sidebands are enriched in accidental and neutron backgrounds. Two of the sidebands are being studied now and the collaboration plans to show data in at least one sideband at the next PAC meeting. The signal region will not be unblinded until good agreement between data and simulation is achieved in all four sidebands.

Plans are also being made for measurements of neutrinos from K^+ decay at rest (KDAR), with the initial goal of providing feedback on charged-current quasi-elastic scattering models. We note that providing such feedback in a form that is useful for model developers can be challenging. We recommend that the collaboration generates a clear plan for the KDAR analysis and identifies specific deliverables that they plan to measure.

E82/JSNS^2-II extends E56/JSNS^2 by adding a second detector 48 m from the Hg target. The PAC recommended stage-II approval at the last PAC meeting, which was granted in April 2022. Construction is underway and is progressing well despite challenging global conditions. A key element of the detector is 228 photomultiplier tubes, most of which have been donated by the Double Chooz experiment. The collaboration will need to procure several PMTs beyond those provided by Double Chooz. The experiment also includes stainless steel tanks which have been completed and an acrylic tank which is being fabricated in Taiwan to be delivered in November. Efforts are underway to ensure that the detector complies with fire regulations and J-PARC safety reviews.

An upgrade of the near detector electronics is also planned. The new system has been developed at the University of Michigan and is fully produced and tested. Final review and preparation for installation is ongoing. This upgrade will extend the dynamic range while maintaining good energy resolution and will provide more trigger flexibility. It appears that this new readout system will not be ready for initial data taking for the far detector.

The PAC congratulates the collaboration on excellent progress with E82/JSNS^2-II construction and progress on E56/JSNS^2 data analysis. We note that there is a history of other experiments that have sought to test the LSND anomaly and ultimately offered inconclusive results. Considering this, we want to reiterate that it is essential that all

steps of the data analysis be conducted with great care, such that they can be clearly communicated and defended to the global scientific community. We look forward to hearing more details of the analysis, including seeing data in sidebands, at the next PAC meeting.

E14 (KOTO)

KOTO is an experiment to measure the rare and CP-violating decay $K_L \rightarrow \pi^0\nu\bar{\nu}$. The branching ratio is highly suppressed in the Standard Model and theoretically very clean, so that its measurement offers a unique opportunity to probe New Physics contributions from high energy scales.

At the this PAC meeting KOTO reported on their progress with the analysis of the data taken in 2019-2021. With respect to the previous 2016-2018 analysis, an Upstream Charged Veto has been installed suppressing the charged kaon background. Concerning the halo $K_L \rightarrow \gamma\gamma$ background, a kinematic multivariate analysis has been employed.

The PAC congratulates the collaboration on their steady progress on background reduction.

The PAC is concerned that numerous issues presented during this PAC meeting need to be understood better. One issue is an increase in the estimated $K_L \rightarrow 2\ \pi^0$ and upstream π^0 backgrounds due to changes in secondary particle production related to photonuclear interactions after a change of the Geant4 version. Another issue is the need to complete the optimization of the neutron suppression cuts and implications on backgrounds. An additional issue arises with inverse cut studies. Based on unexpected background in the signal region in the previous analysis (2016-2018 data), KOTO has expanded their blind analysis plan to examine and understand event distributions in P_T vs Z with inverted cuts. The PAC noted some potential issues with the inverted cuts studies that were shown. Estimated rates in the signal region were systematically lower than the observed rates for three sets of inverted cuts that were shown.

KOTO presented an aggressive plan to show results from the 2021 data at KAON2022 (September 13-16). The PAC repeats a previous comment that the collaboration should take extreme care to avoid problems like those that affected the results of the unblinding in the 2016-2018 analysis. The PAC commends KOTO for improving their blinding procedure to be more robust and stable. We note that a blinding procedure that is not

independent of arbitrary deadlines, such as conferences, may lead to public presentation of a result that requires significant future correction.

E21 (COMET)

The COMET experiment is designed to search for coherent neutrino-less conversion of muon to electron. It will use the new beam line (C-line) that was completed in the Hadron Experimental Hall at the end of March 2022. The international Collaboration gathers about 300 scientists from 48 institutions.

The Phase-α engineering run, meant for proton beam commissioning and diagnostics as well as measuring the pion/muon backward-production yields, is currently under active preparation. It is on schedule to take place in early 2023 within JFY2022. The PAC looks forward to hearing a progress report on Phase-α at the next meeting.

Operation of the cryogenic system for COMET superconducting magnets was carried out successfully for the first time. In this exercise, an issue was identified; the radiation shield of the Transport Solenoid (TS) could be subjected to an immense stress, close to the design limit, in the case of a quench at full current (210 A). The issue will be addressed in the fall of this year, in collaboration with the magnet manufacturer (Toshiba). The issue can be resolved in about a month, and is expected to be completed before the start of Phase-α. We look forward to hearing the solution to overcome this issue at the next PAC meeting.

The realization of the detector components continues to make good progress, more-or-less on schedule. The overall schedule of the experiment has been maintained despite the adverse worldwide conditions. However, there is still some uncertainty due to the geopolitical situation. While some noticeable delays occurred for the Trigger system due to travel restriction of COVID-19, and for the large-scale production of simulated data MC6 (not yet started), the collaboration is on track of commissioning the detector at the beginning of 2024, before starting its Phase-I physics run. This schedule is still marginally ahead of the competing experiment, Mu2e at FNAL. In that respect, it is essential that COMET be given access to the necessary beamtime before the start of Mu2e Physics run (fall 2025).

The PAC strongly supports the beam time requested for the realization of Phase-α and congratulates the collaboration, once more, for its steady progress.

E70

The E70 experiment will perform the spectroscopy of $^{12}_{\Xi}$Be hypernuclei via the ^{12}C(K^-, K^+) reaction, which is an important study in the field of doubly strange hypernuclei. E70 requires the operation of the newly developed S-2S spectrometer with much improved missing-mass resolution compared to earlier experiments.

The PAC congratulates the collaboration on the progress in the setup of the S-2S spectrometer, including the drift chamber installation and the aerogel detector rearrangement. The PAC is happy to see that the ongoing work in the Hadron Experimental Facility is according to schedule.

The cross-section estimate is considered reasonable for the commissioning run. However, some concern was raised about the count rate estimate relying too much on BNL-AGS experiment AGS E885 (Khaustov et al., PRC61, 054603, 2000) for a robust prediction of the experiment's discovery potential. In that experiment, the bound state events were not clearly identified in the missing mass spectrum. As the excess of events is only an indication of discrete hypernuclear states, the extracted potential well depth $V_{0\Xi}$ of about 14 MeV within the Woods-Saxon prescription can only be used for a rough estimate of the E70 count rates. It was suggested to perform calculations with a varying potential depth.

The PAC recommends allocating 3 days of beam time for detector commissioning.

E75

E75 reported their update since the last PAC meeting. They plan to use natural Li as the target instead of the isotopically enriched ^{7}Li due to its recently escalated cost. E75 is considering conducting two measurements with natural Li and ^{6}Li which is available at J-PARC and subtracting the ^{6}Li contribution from the natural Li spectrum. Although the natural abundance of ^{7}Li is as high as 92.5%, the PAC is concerned that the subtraction analysis causes further uncertainties in determining the production cross-section of $^7_{\Xi}$H especially in case $^6_{\Xi}$H has a bound state. The PAC recommends E75 to continue their effort to obtain isotopically enriched ^{7}Li target.

E75 also reported that they were still in the process of determining their systematic uncertainties due to an unknown shape of a continuous spectrum of the quasi-free

scattering. The PAC expects E75 to present their estimation on the systematic uncertainties in the next PAC meeting.

E75 proposes to defer their beam time request until the beam time schedule of the E70 commissioning is fixed since E75 shares the experimental setup, excepting the target, with E70. The PAC encourages E75 to continue their careful consideration of the ^{7}Li target and the continuum spectrum.

E34 (g-2/EDM)

E34 is an experiment to measure the anomalous magnetic moment and electric dipole moment of the muon. It utilizes the innovative approach of using a cooled surface-muon beam accelerated and injected into a storage magnet.

At this meeting, PAC heard many impressive progresses in H-line commissioning. They obtained 8×10^{7} muons at 1MW, with 75% of the expected efficiency. The measured momentum was 28 MeV/c with RMS of 1.2 MeV/c with the expected beam profile. As for muon source development, they showed the first-ever demonstration of muon ionization via 1S-2P from Silica aerogel at U-line, which was also demonstrated at S-line. The production rates were so far about half of expectation from simulation. Further refinement of simulation and improvement of laser stability are on-going. PAC also recognizes that design and fabrication of downstream components in H-line are proceeding well. Engineering design of the site is completed and ready for construction beginning JFY2023, although the final building design was moved to JFY2023 due to budget constraints.

PAC acknowledges the many ground-breaking achievements since the last meeting and congratulates the collaboration. The PAC also congratulates the collaboration on the news that the University of Groningen (Netherlands) has joined, and that a position of assistant professor has been created by IPNS for the construction of the g-2/EDM facility. The PAC takes note that IPNS is preparing a review of the experiment which should be completed before the next PAC meeting. PAC is looking forward to seeing first-ever acceleration of thermal muons expected in 2023 as the next big milestone. To accelerate further developments, it would be good to involve more human resources from international partners in the leadership positions of the collaboration.

E71 (NINJA)

NINJA studies neutrino interactions in water using a lead/emulsion sandwich detector immersed in water. A scintillator tracker along with emulsion shifter provides timing and position resolution of 10 ns and 1 μm, respectively. Baby-MIND provides momentum and charge information for the muons produced at NINJA. In March 2022 NINJA completed scanning and digitization of E71a data (4.8×10^{20} POT) that had been acquired November 2019-February 2020 with a 250 kg target (including 75 kg water, 130 kg iron).

Technical papers based on run E71a on high-speed emulsion scanning and scintillator-emulsion track matching have been published. A third paper, describing momentum reconstruction using multiple Coulomb scattering, has been submitted. Preliminary distributions of muon and proton angle, momentum, and multiplicity from neutrino-water interactions from a subset of E71a have been compared to simulation. The committee looks forward to seeing advanced results from E71a.

NINJA is preparing for run E71b in Fall 2023 with an anticipated exposure of 5.2×10^{20} POT and a ~1000 kg target. The increase in target mass takes advantage of an automated emulsion pouring system that is ten times faster than hand fabrication. An automated scanning system at Nagoya University is five times faster than the current system. The location of the larger detector for the E71b run is under discussion with T2K and the J-PARC neutrino group.

Prospects to deduce ν-n interactions from the difference between ν interactions on water and D_2O targets were presented. The committee noted that it may be difficult to study such interactions considering the large rate of ν-Oxygen interactions. We encourage NINJA to complete quantitative feasibility studies for this concept.

A meeting to discuss joint analysis between T2K and NINJA has occurred, and offline communications continue. A joint analysis has a potential to reduce systematics related to the neutrino-nucleus interaction model as T2K strives to improve their oscillation analysis. We look forward to hearing the progress on such a joint analysis at the next meeting.

We congratulate NINJA on their progress in the analysis of E71a and in the preparations for run E71b.

E73

PAC has recommended stage-2 approval for E73 with 80kW beam and 25-day for data taking in the 33rd meeting. At this PAC meeting, the experiment requested an additional day for calibration reaction $p(K^-,\pi^0)$ at 80kW.

This PAC recommends allocating the 25-day 80kW beam for the experiment, in early 2023 if the schedule and the budget permits. The newly requested additional day of $p(K^-,\pi^0)$ run should be included in the originally requested beam time. Note that the exact length of the run will be determined according to the JFY23 budget, schedule, and the availability of the intense beam requested by E73.

P86

The proposed experiment P86 aims to pin down the interaction between Λ and nucleon precisely including spin observables. The physics impacts and importance of the project were already discussed in the 32nd PAC meeting and they have already been evaluated highly. After the 32nd PAC meeting, the proponent made efforts to confirm the feasibility of the measurement with the existing E40 experimental data, which had been taken with similar apparatus as the proposed experiment. PAC recognizes that the analysis of E40 data demonstrates strong support for the feasibility of the proposed experiment.

The proponent also presented the detector development status for the proposed experiment and showed that detector components of the beamline spectrometer are almost complete. However, the main detector (CATCH) upgrade and detectors for the SKS spectrometer are not funded yet. The proponent requested stage-1 status for further development to realize the experiment.

Based on the status of the proposal together with the importance of its physics measurement, PAC recommends stage-1 status for the P86. One concern is the uncertainty about when the proposed experiment can run and on which beamline. The proponent expects to perform the experiment at the K1.1 beamline in the extended Hadron Experimental Facility. PAC recognizes the necessity of further discussion together with the Lab/Facility management when the proponent requests stage-2 status.

P93

Adding functionality to accept secondary beam in the current high-momentum beamline promises to open new opportunities to enhance the physics programs at J-PARC. A couple of proposals and several LoI have already been submitted to the PAC. In the last PAC meeting the importance of the high-momentum secondary beam line has already been discussed and well recognized.

In the last half year, the proponent has discussioned with the Lab/facility management how to realize/upgrade the high-momentum beam line to accept secondary beams and proposed a 3-step process. PAC supports the effort made by the proponent together with the Lab/Facility management and wishes that they keep momentum to realize the high-momentum secondary beam line.

In addition, for this PAC meeting, the proponent made a specific proposal to investigate the properties of the beamline transportation optics. PAC recognizes the value of such a test experiment.

Since this proposal is neither a physics experiment proposal nor a feasibility study for an experiment, it does not fall within the mandate of the PAC. However, PAC requests the proponent to continue discussion with the Lab/Facility management on technical feasibility, possible resource allocation, and scheduling of the proposed test measurements.

P94

This proposed experiment is to measure the (π^+, K^+) reaction at 1.05 GeV/c, leading to $^{7}_{\Lambda}$Li, $^{10}_{\Lambda}$B and $^{12}_{\Lambda}$C hypernuclei. It will use the new S-2S spectrometer which is expected to yield energy level measurements with 1 MeV FWHM and peak resolution of 100 keV. This level of precision hypernuclear spectroscopy will mean a major leap forward for the subject.

Apart from establishing the resolution of the new spectrometer key physics goals should include:

- checking a potential error of order 0.5 MeV in the use of the $^{12}_{\Lambda}$C hypernucleus for energy calibration
- a precise measurement of the $^{10}_{\Lambda}$B hypernucleus as a new check of the size of charge symmetry breaking in Λ hypernuclei by comparison with the $^{10}_{\Lambda}$Be hypernucleus measured by HKS at JLab.

The requested beam time is 10.5 days using a similar set-up to that used for E70 (noting the change from a K^- to a π^+ beam), which the proponent would prefer to run first. The PAC recommends stage-1 status for P94.

P95

P95 proposes to measure the cross-section of the pion-induced ϕ-meson production on the proton and to examine a possible ϕ-N resonance around 2.2 GeV center-of-mass energy. This possible resonance was observed in the ϕ photo-production on the proton, but its nature is still unclear. P95 is also motivated by a speculation that this possible resonance might be an exotic pentaquark state P_s relying on analogies between the strange and charm sectors.

P95 proposes to bombard a liquid hydrogen target with a secondary negative pion beam at 1.6–2.4 GeV/c delivered by the π20 beam line and will measure K^+-K^- pairs emitted from the ϕ decays with the E16 spectrometer.

The PAC shares the scientific interests with P95 in the vector meson + nucleon channels where several puzzles remain but is still not convinced that it justifies their long beam time request of 55 days. The PAC requests P95 to present their strategy on how they will clarify the internal structure of the ϕ-N resonance. The PAC considers that P95 proponent needs further discussion with theorists.

The construction of the π20 beam line is also an issue. P95 should discuss the beam line construction with the Hadron facility and present a roadmap to develop a high-intensity secondary negative pion beam. The PAC hopes that a higher beam intensity than the present expectation will enable P95 to shorten the beam time request.

P96

P96 is a proposal to measure the X ray from Ξ^--C atom. The Ge γ/X-ray detector array (Hyperball-X') is placed around the Active Fiber Target (AFT) in the E70 run. With such configuration one expects the detection of the X ray from the (K^-, K^+) event identified by the S-2S and AFT. This is the third try to measure the X ray from Ξ^- atoms. In the previous experiments, E07 and E03, no clear peak structures have been found. The reasons for weak signals were examined, and it is considered to be necessary to have both good enough S/N and large enough yield, which were not achieved in the previous measurements. In P96, both conditions are improved. In addition, by measuring the X ray

during the E70 run as a parasitic run, P96 will not impact available beamtime for other experiments. The feasibility of P96 seems to be high. It is noted, however, an additional 1-day beamtime exclusive for P96 during the physics run period of E70 is requested.

The PAC recommends the stage-1 status for P96. The PAC also recommends P96 to prepare for the experiment and expects them to submit document(s) for the stage-2 approval at the next PAC meeting to run with E70 which may be performed in 2023.

E31

The result of the measurement of the K^--d reaction leading to a slow neutron and $\bar{K}N$ or π-Σ final states was presented. The various charge states were used to isolate isospin 0 and 1 components of the π-Σ final states and various checks based upon isospin constraints were well satisfied.

The isospin zero $\bar{K}N$ scattering length and effective range were extracted using a simple re-scattering model. It would have been helpful to see a comparison with other estimates of these values. A publication presenting the results is nearing completion.

PAC congratulates the collaboration on the success of the measurement and look forward to the final publication of the results.

E16

E16 reported the expected increase of the DAQ live time. Two microstructures of the beam, 5.2-μs and 5-ms, likely come from the dispersive optics at the Lambertson magnet and the low-frequency current ripple of magnet power supply. With the help of the BL and SX groups, E16 expects that the new (zero-dispersion) optics and the replacement of the magnet power supply will improve the microstructures. In addition, E16 evaluated the improvements of the DAQ system and other improvements as pointed out by the FIFC. As a result, the live time is expected to increase from 15 % to 55 % (with the same beam structure), 85 % or 70 % (with improved beam structure, 1 kHz or 2 kHz). The PAC appreciates the works by E16, BL and SX groups, and FIFC.

To confirm these improvements, beam study & trigger study are required before the physics run. E16 requested the beam time for those studies, 101 h (including 53 h only for the B-line) to confirm the beam structure improvement, and 100 h for the trigger study. The PAC recommends the beam time to be assigned in 2023. The proponent also showed the estimate of the physics run (Run-1) beam time of 1920 h, which is longer than the

original 1280 h. E16 is requested to confirm the technical feasibility after the test beam-time, and to update the necessary documents for the FIFC; the documents should include the re-evaluation of the physics run request. PAC will then consider Stage-2 and Run-1 approval requests.

E80

E80 aims to study kaonic nuclei focusing on the $\bar{K}NNN$ system. In the previous PAC meeting, E80 proposed P92 to examine the $\bar{K}NNN$ nucleus with the existing experimental setup because a candidate for the $\bar{K}NNN$ nucleus was observed in the T77 beam time. However, the situation has changed since the previous PAC meeting.

The PAC congratulates that E80 has successfully obtained a large research grant from MEXT to construct most parts of the new cylindrical detector system. The PAC agrees with their strategy, namely, that E80 concentrates all efforts on the preparation of E80 and suspends P92 for the time being.

The FIFC reviewed the TDR submitted from E80 and gave several comments on the superconducting solenoid magnet, detector structure, and target system. The PAC requests E80 to consider those comments carefully and update the TDR for the stage-2 approval request.

The PAC also encourages E80 to continue the collaboration with theoretical groups for further clarification on the internal structure of the observed state. The PAC appreciates that E80 has appointed a new postdoc for the theoretical study of the kaonic nuclei.

4. GERAL REMARKS AND RECOMMENDATIONS

The committee was pleased to learn that the MR power supply proceeds well, despite some small problems and that the beam is scheduled to return in November as planned. In fact, the first beam in MR was circulated in July, although not yet accelerated, which is particularly good to hear. RCS/MLF has operated smoothly. We were particularly excited to learn that the muon H1-line has been completed and is operational at MLF. At KEK, SuperKEKB has achieved the impressive luminosity of 4.7×10^{34} cm^{-2}/s, although there is still some way to go towards the design luminosity. The other excitement is the recent restart of LHC run 3 where KEK has made and continues to make important contributions. The PAC also appreciates the good communication and operations

maintained by KEK and J-PARC as well as the efforts to bring foreign collaborators back to the experimental sites.

KEK roadmap 2021 has been published as well as the Project Implementation Plan 2022. It is good to see the emphasis on J-PARC operation (six months per year or longer) as well as upgrades needed for HyperK, preparation for g-2/eDM and COMET as well as the Hadron Experimental Facility Extension.

There are several worrying issues, however. The slow approval process at the Nuclear Regulation Authority for Radio Isotope Facility modification that we noted last time persists and may eventually cause delays to the start of some of the new constructions. COVID-19 and related supply chain issues persist and have caused delays and problems in both laboratory projects and experiments. The international situation brings further uncertainties.

Most worryingly, the energy costs in Japan continue to skyrocket, eroding the ability to operate the facility. The funding projected to be required for operation in this year is approaching a factor two above that estimated a year ago. This situation brings extreme uncertainties both short-term and long-term.

There are many unknowns for running scenarios after the return of the Main Ring beam in November to the beginning of Summer 2023. This includes the funding situation at JAEA, that may prematurely terminate the LINAC/RCS operation in JFY22 as well as the allocation of operation funds for JFY23. Both should be known better at the time of the next PAC meeting.

Given the uncertainties, the committee recommends the following for the start of operations later this year. November and December will be taken up by necessary machine studies that were delayed from earlier. There is about a month of bakeout run planned for the Main Ring beginning in mid-January. During this time, T2K should be able to work for beamline commissioning. This period will be followed by re-establishment of the Hadron Experimental Facility operation as well as the preparation and running of COMET phase-alpha. This is expected to last about 1.5 months. During the second period, it may be possible to run short low-intensity slots for Hadron Experimental Facility experiments. If this is possible, short runs such as commissioning of E70, should be considered. It is likely that this second sequence will be interrupted by the funding situation at JAEA that prevents the operation of the LINAC/RCS. This interruption may be up to 6 weeks. Considering the maintenance days and switching times,

this will bring the end of the second period well into JFY23, likely the end of April or beginning of May.

As we embark on the running period between the MR upgrade and start of HyperK/Hadron Experimental Facility extension, it is important to consider beyond the short term in planning the running schedule. We will have a better idea of length of running in JFY23 at the next PAC meeting which will be after the budget decisions. Rather than recommend plans that may need to be revised at that time, we propose to wait until the next PAC meeting for recommendations on running scenarios after April.

The 34th PAC was held in hybrid mode, and some members of the committee had the great pleasure of visiting J-PARC again and to engage with the J-PARC and KEK staff as well as the researchers from many institutes in person, after a long absence. Physical presence greatly enhanced the interactions between the PAC members and relevant researchers from experiments, despite some of the difficulties of the hybrid meeting mode and COVID restrictions. We would like to thank the staff at J-PARC and KEK very much for arranging and running the meeting so smoothly, especially considering the challenging circumstances.

5. DATES FOR THE NEXT J-PARC PAC MEETING

The next J-PARC PAC meeting will be held around the middle of January 2023.

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

- Minutes of the 33rd J-PARC PAC meeting held on 19-21 Jan., 2022 (KEK/J-PARC-PAC 2022-15)
- Proposals:
  - New generation Λ hypernuclear spectroscopy with the (π^+, K^+) reaction by S-2S(KEK/J-PARC-PAC 2022-18)
  - Pion-induced phi-meson production on the proton(KEK/J-PARC-PAC 2022-19)
  - Measurement of X rays from Ξ − C atom with an active fiber target system (KEK/J-PARC-PAC 2022-20)
- Technical Design Report:
  - Technical Design Report on the E80 Experiment: Systematic investigation of the light kaonic nuclei (KEK/J-PARC-PAC 2022-16)
  - Addendum to the J-PARC E16 Technical Design Report – for Run-1 approval – (KEK/J-PARC-PAC 2022-17)
- Reports:
  - Proposal for a test experiment to evaluate the performance of the secondary beam in the high-momentum beam line (Revised proposal of P93) (KEK/J-PARC-PAC 2022-21)
  - Memorandum for the J-PARC E80/P92 experiment Reply to the Minutes of the 33rd PAC (KEK/J-PARC-PAC 2022-22)