To be approved at the 31st PAC meeting
KEK/J-PARC-PAC 2020-12
November 3, 2020

J-PARC Program Advisory Committee

for the Nuclear and Particle Physics Experiments

at the J-PARC Main Ring

Minutes of the 30th meeting held
20(Mon.)-22(Wed.) July2020

OPEN SESSION:

1. Welcome and Mandate to the Committee — K. Tokushuku (KEK)
2. Welcome and J-PARC Center Report: — N. Saito (J-PARC/KEK)
3. J-PARC Accelerator Status & Plan: — Y. Sato (J-PARC/KEK)
4. Hadron Facility Status & Plan: — H. Takahashi (J-PARC/KEK)
5. P78 (8GeV Operation Test and Extinction Measurement) — H. Nishiguchi (J-PARC/KEK)
6. E14 (KOTO): — N. Shimizu (Osaka)
7. E40 (Measurement of the Cross Sections of Σp Scattering): — K. Miwa (Tohoku)
8. E56 (Sterile Neutrino Search): — T. Maruyama (J-PARC/KEK)
9. E71 (NINJA): — T. Fukuda (Nagoya)
10. T2K(E11) / T2K-II (E65): — C. Giganti (LPNHE)
11. ND280 Upgrade Review Report: — T. Sumiyoshi (TMU)
12. E21(COMET): — S. Mihara (J-PARC/KEK)

13. E34(g-2/EDM): T. Mibe (J-PARC/KEK)
14. P79 (Search for an I=3 Dibaryon Resonance): T. Ishikawa (Tohoku)
15. P80 (Systematic Investigation of the Light Kaonic Nuclei): F. Sakuma (RIKEN)
16. T77 (P73: Feasibility Study for $^{3}_{\Lambda}H$ Mesonic Weak Decay Lifetime Measurement): Y. Ma (RIKEN)
17. E03 (Measurement of X-ray from Ξ^- Atom): T. Yamamoto (JAEA)
18. E16 (Measurement of Spectral Change of Vector Mesons in Nuclei): S. Yokkaichi (RIKEN)
19. E42 (H dibaryon): J.K. Ahn (Korea)
20. Beam Time Schedule in 2018-2021 T. Kobayashi (J-PARC/KEK)

CLOSED SESSION:

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

1. PROCEDURAL REPORT

The minutes of the 29th J-PARC-PAC meeting (KEK/J-PARC-PAC 2020-04) were approved.

2. LABORATORY REPORT

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

The director of Institute of Particle and Nuclear Studies (IPNS), Katsuo Tokushuku, welcomed the PAC members. Tokushuku reported on the renewal of the committee membership of the Program Advisory Committee for the Nuclear and Particle Physics Experiments 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.

Tokushuku reported recent KEK-IPNS activities amid the COVID-19 period. He reported that KEK managed to keep operating the accelerators. At J-PARC, successful start of the new high-momentum beamline (B-line), operation of the new production target in the hadron experimental hall as well as first data taking of the sterile neutrino experiment at MLF (E56) were achieved. He also reported that the SX operation was slipped from February to May because of a delay in permission from the Nuclear Regulation Authority. This delay impacts on the future planning; start of the long shutdown is shifted from April to July 2021.

Tokushuku explained middle/long-term plans. He reminded the committee that the long shutdown is scheduled in 2021 to install the new power supply system for the MR magnets, in order to be ready for the high-power operation in JFY2022. He explained the budget and run plan of the 3.5 cycles for JFY2020 and JFY2021. Regarding the KEK long-term plan, recent reviews in Science Council of Japan (SCJ) and MEXT were explained. KEK submitted 10-years J-PARC plan to the SCJ Master Plan 2020. This plan includes MR and neutrino facility upgrades, Hadron Hall Extension, COMET-II, g-2/EDM and operation of J-PARC. The plan has been ranked as one of the thirty-one most important projects. Subsequent selection process for MEXT Roadmap 2020 is scheduled in August.

Tokushuku requested the PAC committee to give recommendations on beam time allocation in the near term based on the guideline, and to give advice on the middle/long-term plans along with any other issues after he reminded general mandates and approval process of proposals. He described what IPNS has done after the 29th PAC meeting. Following the PAC recommendations, stage-1 status was given to the experiment E75. A test experiment (T77) was performed. The T77 group took data in June and will report the result in this PAC meeting. He also mentioned that three new proposals (P78, P79 and P80) have been received for this PAC meeting, about which he requested the PAC to make evaluations. He also requested the PAC to evaluate a pending proposal, P73, with the outcome from T77. The E65 (T2K-II) group submitted an addendum of the ND280 upgrade TDR to this PAC meeting. The final report from the review committee for the T2K ND280 upgrade has been received by the IPNS. As stated in the previous PAC meeting, the beam time prospect for the neutrino experiments after the power upgrade has been discussed between the experiment groups and KEK management. KEK has issued a statement: “KEK’s plan for future neutrino experiments at J-PARC”, which was shown in his presentation. Tokushuku requested the PAC to evaluate T2K-II for the stage-2 approval with these inputs.

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

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

The J-PARC Director, Naohito Saito firstly mentioned that J-PARC was suffering from COVID-19 as well as many labs all over the world. He reported that J-PARC operation was paused in mid-April and restarted in mid-May by careful preparation of preventive measures against COVID-19 at J-PARC. He gave an overview of the J-PARC facilities as well as science at J-PARC. Saito showed the operation status of J-PARC and mentioned that the operation of Main Ring (MR) with the fast extraction (FX) mode was established at over 500kW beam power. He conveyed that the Hyper-Kamiokande (Hyper-K) project has been funded. Saito also reported the commissioning of the new hadron-production target and the new beamline called B-line for transporting primary proton beam in the Hadron Experimental Facility. These systems worked successfully in the last SX beam time from May to June. Saito presented the status of Material and Life Science Facility (MLF). He explained that the 1MW beam power operation is now realized after a series of trial operation with increasing continuous operation time. There are several particle physics projects at MLF: sterile neutrino search JSNS2 (E56), precise measurement of muon g-2/EDM (E34) and neutron fundamental physics, e.g.

measurements of its lifetime and EDM. He also introduced the design of muon facility at MLF (MUSE).

Saito explained recent actions at J-PARC/KEK for future projects. He mentioned that the J-PARC upgrade for Hyper-K has been the highest priority in the KEK Project Implementation Plan (KEK-PIP) and was finally approved by the Japanese government. He explained that KEK and J-PARC submitted J-PARC operation and upgrade plan to the Science Council of Japan (SCJ) to be included in its Master Plan 2020, in which realization of 1.3MW and 9-cycle operation of the MR is included for the purpose of CP violation search in the neutrino sector in T2K/T2K-II. In particular, he mentioned that the J-PARC plan, which includes facility operation as well as facility upgrade (Hadron hall extension, COMET-II and g-2/μEDM), was selected as one of the 31 important projects among 160 proposals. The MEXT Roadmap 2020, which selects large-scale projects to be funded in Japan, will base on the Master Plan 2020. He also reported that the International Advisory Committee scheduled in February and KEK Scientific Advisory Committee Meeting (SAC) scheduled in March were canceled due to the pandemic.

Saito showed the budget request from KEK to MEXT for JFY2021, which includes operation for 1.5 cycles (limited due to new power supply installation as planned for coming years) and completion of new power supply installation for realizing higher repetition rate of MR operation as the highest priority. In addition, he also showed that as a KEK responsibility in the Hyper-K project power upgrade of MR to 1.3MW and facility construction for the intermediate detector were requested. Saito concluded his talk by mentioning recent growing collaborations with academia and industry in the world at J-PARC.

2-3 J-PARC Accelerator Status (Yoichi Sato, J-PARC/KEK)

Yoichi Sato reported the status of J-PARC accelerator, mainly about the MR. He explained the beam power history of RCS and MR. In June 2020 1MW beam operation was successfully realized at RCS to provide high-power beam to MLF for 36 hours, which is a significant step to achieve the design beam power. MR operation has achieved 515kW and 51KW operation for FX and SX respectively, which is the highest beam power ever achieved. He also explained the operation statistics of MLF and FX/SX in JFY 2019-2020. They successfully provided the beam to MLF with larger availability than 95% in JFY 2019-2020 while the beam availability in FX and SX was around 90% except for SX beam availability of 79.8% in JFY 2019 although this lower beam availability was due to the trouble of B15D magnet as reported in the previous PAC meeting.

Sato explained the status of beam tuning of RCS; the RCS has two purposes to provide high-power beam to MLF experiments as well as injection beam to MR. The MLF experiment facility requires a wide-emittance beam to mitigate a shockwave on the neutron production target with sufficiently low beam loss while MR requires a low-emittance beam for the purpose of further acceleration. They realized both by introducing pulse-by-pulse parameter switching. For the purpose of even higher beam power operation they succeeded in operating the RCS at 1.5MW-equivalent protons per pulse by widening injection pulse width and increasing injection peak current.

Sato then explained status of beam tuning of MR both for FX and SX. After summarizing operation principle of MR for FX and SX, he introduced how to increase the beam power with suppressing beam instabilities during acceleration and localizing beam loss in the collimator regions for FX. As for SX, he explained the details of controlling beam stabilities both in longitudinal and transverse (vertical) during the de-bunching process. He explained also a result of SX test operation at 60kW. They observed beam loss before and at the beginning of the extraction process, which requires further beam study.

Sato showed a mid-term plan of MR in the period of JFY2020-2024 along with a conceptual idea of beam power upgrade; increasing the number of protons and reducing the repetition cycle time. They have been working on manufacturing new magnet power supplies, 2nd harmonic RF system, FX kicker power supply improvement and new septa, and upgrade of collimator capacity in MR. These activities will be completed with their installation in a long-term shutdown period in JFY 2021. They plan to start this significant installation work of new equipment in May 2021, followed by a series of tests and beam commissioning in 2022.

Sato summarized his presentation by showing MR operation schedule in October 2020 – March 2023. They plan to install new devices in 2020 summer shutdown; a beam diffuser in front of SX Electro-Static Septum (ESS), an OTR-II beam profile/halo monitor, and a 2nd harmonic RF system. In December 2020 they plan to carry out SX/FX tuning to restore the stable operating condition, followed by 2-cycle user operation in January - March 2021 with 60 kW and 500 kW beam power for SX and FX respectively. In April – June 2021 MR is ready for 1.5-cycle user operation. Then MR will be shut down in the period of July 2021 – March 2022. Before the summer shutdown in 2022 they plan to carry out high-power test of newly installed devices for SX/FX in April – May 2020, and FX beam tuning with 1.32 sec beam repetition cycle in June 2022. By then, they will be ready for user operation for FX with a beam repetition cycle of 1.32 sec in Fall 2022. SX operation is anticipated afterwards, and SX beam repetition cycle is to be determined at this occasion.

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

Hitoshi Takahashi reported on the status and plan of Hadron Experimental Facility. The report included a summary of recent beam time, and results of first beam commissioning of the new production target and new primary beam line.

First, he summarized beam operation of the recent SX run. It was carried out from May 23rd to June 26th, and E40, E03(beam test), T77, E14, and E16 experiments acquired data in this period. The first beam commissioning of the new production target and new primary beam line (B-line) was also conducted, and they passed the facility inspection for obtaining a license as a radiation facility. Beam availability during the user time was rather low, 82.6%. In Hadron Experimental Facility, the main source of the beam interruption was MPS (Machine Protection System) signals from the beam loss monitors, which were caused by larger amount of beam extraction to the B-line than the limit. This situation was significantly improved after optimizing the MR device (RF offset) on June 6th.

The first beam exposure to the new production target was conducted in this SX beam time. The whole system of the new target worked properly up to a beam power of 51kW, while the maximum allowed beam power of the new target is 95kW (at a 5.2s-spill cycle). Measured temperature was in good agreement with the calculation within 10% accuracy. It was found that the change in the beam position during a beam spill could be determined by measuring the temperature difference between thermocouples mounted on different positions on the target.

The new primary beam line (B-line) is a beam line branched out from the existing primary beam line (A-line), and 2.6×10^{10} protons/spill at maximum are directly served to user experiments. The first beam commissioning of the B-line was performed during this run. A stable beam delivery with an intensity up to 10^{10} protons/spill was achieved. Because the B-line intensity depends not only on the SX beam intensity but also its emittance, it must be re-tuned after any setting changes were made. The beam profile at the experiment target location was precisely measured using scattered particles in the target chamber. The beam width was found to be smaller than expected. The beam halo was reduced to within the design margin of the E16 detector with collimators on the beam line. They also successfully improved the spill structure by dynamic ramping of the steering magnets on the beam line.

Finally, Takahashi showed the construction schedule of the new primary beam line for COMET (C-line). It will be completed in the coming 2 years, and the first beam to COMET will arrive in winter JFY2022 at the earliest.

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

P78 (COMET Extinction Test)

To attain its physics goal, the COMET experiment (see dedicated E21-section of this PAC report) relies on an 8GeV proton beam with bunches 1.2μs apart, instead of the nominal 30GeV proton beam with bunches 0.6μs apart.

It is critical for the experiment to suppress drastically the fraction of the residual proton beam that could be kept in between bunches. This suppression is quantified by a so-called extinction factor that should stay below 10^{-10}. The basic idea to achieve this beam structure is to start by a beam in RCS with a single filled bunch, instead of two: the second bunch being kept empty. After injection in the MR, one obtains the desired 1.2μs spacing with 4 bunches, instead of 8.

However, the second RCS bunch is not strictly empty. It corresponds to an extinction factor of $\sim 10^{-6}$ that must be further reduced. This is achieved by a customized kicker-timing scheme, so-called SBK (Single Bunch Kicker), meant to avoid injecting in MR the second RCS bunch. Once completed by a tuning of RF voltage to remove residual leaks in between bunches, this scheme was established to work early 2018, at least for 3 out of the 4 bunches.

It was observed that the fourth bunch was still followed by a remnant of a secondary bunch. If not corrected, the fourth bunch could not be used, thereby implying a 25% efficiency loss. This issue was later solved early 2019, thanks to a further refinement of the SBK scheme, but this was established using a low intensity beam in the MR abort line, not with the nominal intensity HD SX beam. Early in 2020 another test was performed to probe a different SBK scheme (so-called Backward SBK) with encouraging results.

The purpose of P78 is to better establish the procedure to obtain the customized beam needed by COMET. The proposed campaign consists of 6 days of data-taking in the K1.8(BR) line. A detailed schedule was provided to the PAC, through a written proposal and a dedicated presentation. The foreseen campaign covers the 8 GeV running (acceleration, injection/extraction, and transport) together with an in-depth mastering of the extinction factor. The realization of this important program has gathered 10 institutes from 6 countries.

The PAC congratulates the COMET collaboration and the J-PARC Accelerator group for the timely and convincing proposal put forward to reach this important milestone of the COMET project. The PAC considers that the P78 proposal should be given a high priority in the beam–time allocation.

E14(KOTO)

The E14 (KOTO) experiment searches for the CP-violating decay $K_L \rightarrow \pi^0 \nu\bar{\nu}$ at the J-PARC neutral beam line. KOTO unblinded their 2016-18 data set in fall 2019. The expected background of 0.3 events (after inclusion of $K^\pm$ background) and observed 4 events were described at the last PAC meeting.

The new background from charged K semi-leptonic decays has been further studied. The primary source is identified as charge exchange on the downstream collimator face. They measured the $K^\pm$ rate in 2020 (Run 85) by measuring $K_\pi2$ decays and observed 3 times more events than predicted by MC. They are analyzing data with the sweeping magnet turned off and an enhanced $K^\pm$ sample.

They now predict 1.02±0.28 background events in the 2016-18 data set, dominantly from K^+_{e3} (up from 0.05 in the initial study).

KOTO reported additional results from their Run 85 (May-June 2020 run): kaon yield per proton is 88% of old target, they observe some suppression of accidental rates due to the new iron wall, they ran with a prototype upstream charged veto (UCV). They measure a 30% UCV tagging inefficiency due primarily to limited coverage and MPPC noise, based on this KOTO plans to construct a new upstream charged veto (UCV) and requests 60kW × 40 days (2 months) beam time.

The PAC congratulates KOTO on their improved understanding of the charged kaon semi-leptonic decay background. The PAC expresses concern over the robustness of the KOTO blinding procedure and would like to see a description of an improved procedure that will not be defeated by human error in analysis or calibration. The background should be measured with appropriate granularity to ensure that the signal cut definition is being consistently applied. The PAC endorses KOTO's planned UCV detector design and construction and their request for beamtime.

E40(Σp)

E40 aims to elucidate the ΣN interactions by measuring differential cross sections of the Σp elastic scattering and the $\Sigma^{-}p \rightarrow \Lambda n$ conversion reaction. Previously they have completed two production runs, in the 2018 spring (June, 2 days) and 2019 spring (February-April, 20 days for $\Sigma^{-}p$ (17 M $\Sigma^{-}p$) and 13 days for $\Sigma^{+}p$ (40 M $\Sigma^{+}p$). The third production run was scheduled in 2020 spring (February-March, 1.5 days to start up and 14 days for $\Sigma^{+}p$). During the delayed 2020 June run, the experiment collected about 37M $\Sigma^{+}p$ and about 80M $\Sigma^{+}p$, in total. As a result, the total number of the $\Sigma^{+}p$ scattering events were doubled. In addition, crucial calibration for the CATCH was done. The efficiency was measured as a function of the vertex position and angle as well as proton energies. This calibration is important for future analysis.

The data analysis progresses well. The PAC congratulates the group on successful data taking and expects physics results. In addition, the PAC also encourages E40 to finalize the NN scattering analyses including systematic errors and to provide an update to the existing world NN dσ/dΩ data.

E56(JSNS2)

E56-JSNS2 is designed to look for sterile neutrinos by observing muon antineutrino to electron antineutrino oscillation with a baseline of 24 m. It is a direct check of the result from LSND using very similar experimentation with a detector filled with 50t of liquid scintillator installed at MLF. We have heard a progress report from the collaboration. The PAC congratulates the collaboration for their successful first physics run. Due to COVID-19, filling of the detector with liquid scintillators onsite was delayed from February to the end of May. The first physics run with a total of 8.46×10^{20} POT took place on 5-15 June.

During the shutdown on 10 June, calibration of the detector with LED and ^{252}Cf was carried out. Initial studies of the raw beam and calibration data showed the detector was working. After the run, the liquid scintillator was extracted from the detector without any problem in about two days. The plan is to re-install the filled detector early in November in order to collect more data around 9 November.

Currently, the collaboration is estimating the numbers of accidental and cosmogenic fast-neutron background events for the first run. The goal is to report first results and strategy by the next PAC meeting.

It appears that the triggering scheme for amassing physics data is the bottleneck of the experiment. We recommend the collaboration to establish an efficient IBD trigger based on the existing hardware for the November run while pursuing upgrade trigger-data processing electronics in parallel. The PAC would be interested to see any data on Gd-LS performance stability after detector removal/installation, and recommends that the collaboration documents the measured optical properties of the Gd-LS and LS (such as attenuation length, transmission, and light yield) before and after each physics run.

The PAC congratulates the team for collecting its first data and looks forward to a more complete analysis of detector performance at our next meeting (and results from an IBD trigger).

E71(NINJA)

E71 (NINJA) is an experiment to study neutrino-water interactions with an emulsion-water sandwich detector. NINJA has now taken data with its emulsion water target in the middle of the WAGASCI detector. With this placement the muons that leave NINJA can be momentum and charge analyzed by BABY-MIND.

At this meeting NINJA reported on the substantial progress they have made towards their physics goals: they have now accumulated about 50% of their requested data by collecting 4.8×10^{20} POT with a water-emulsion target in neutrino mode. Plots were shown to demonstrate that the emulsion shifter and scintillation tracker performed as expected, and high tracking efficiency was demonstrated. NINJA showed a few event displays of neutrino interactions on water. At the time of the PAC meeting all emulsion films were developed, including a 2 month delay due to COVID-19. The scanning of the physics data started at the end of June.

NINJA also showed event distributions from the 7.1×10^{20} POT antineutrino exposure that was completed before the previous PAC meeting. These event distributions included systematic uncertainties, and at the PAC meeting an extra slide was shown demonstrating the largest components. It was not clear to the reviewers how those systematic uncertainties were evaluated.

The PAC encourages NINJA to develop more fully the plans for making an impact with their data: in particular, what measurements are planned, and how are those measurements accessing something different from what T2K's Near Detector is measuring? What are the expected systematic and statistical uncertainties on those measurements, and how might they be able to help inform models of neutrino interactions? (Or will they be added in some way to T2K's near detector fitting infrastructure?) The PAC would like to see more details on how the systematic uncertainties are or will be evaluated.

The PAC congratulates NINJA on collecting the first half of their requested data set and encourages the development of an analysis strategy while the physics data emulsion scanning is progressing. The PAC recommends collaborative discussion with other T2K collaborators and also with nuclear theorists about strategy how to integrate all the information obtained from NINJA, WAGASCI, and the ND280 Upgrade to improve neutrino interaction modeling, and model validation.

E11/E65/ND280 Upgrade Review Report (T2K, T2K-II)

The T2K collaboration has announced the first 3-sigma exclusion of roughly half of the values of δ_{CP} using the Run 1-9 data sets. The PAC heard the recent T2K results including Run 10 with an improved flux prediction based on the NA61 replica-target measurement and an updated neutrino interaction model. These measurements were also highlighted at Neutrino 2020.

The T2K measurements of θ_{23} are now showing a slight preference for non-maximum mixing. Good agreement in the value of θ_{13} with those measured by the reactor-based experiments was shown. The CP conserving values are excluded at 90%CL. There is mild tension in the δ_{CP} results between T2K and NOvA. The PAC is happy to hear that an MOU has been signed to perform a T2K and NOvA joint analysis which may clarify the situation. In addition, another MOU for joint analysis of T2K and SK is also signed.

T2K has requested 52 days and 4.0×10^{20} POT in JFY2020. The experiment reported that this is the minimum necessary POT to establish the performance of SK with Gadolinium loading before the long shutdown. This amount of beam will also provide samples with the new WAGASCI/Baby-MIND detector that will allow the experiment to address specific concerns associated with the neutrino interaction model, which is currently the largest source of systematic uncertainty in the T2K oscillation measurements. Additionally, 4.0×10^{20} POT in JFY2020 will allow a measurement of NCQE with neutron tagging that will benefit DSNB searches before JUNO. Availability of the off-axis ND280 during JFY2020 is still uncertain due to COVID-related travel restrictions.

T2K-II originally proposed to collect 20×10^{21} POT in order to establish CP violation at $\delta_{CP} = -\pi/2$ with more than 3-sigma significance, to measure θ_{23} with a precision of better than 1.7 degrees for resolving the issue of maximum mixing, and better than 1% fractional precision in the mass-squared difference. The group argues that there is a good chance (40%) to pin down CP violation at 3σ even with 10×10^{21} POT. Therefore, they request stage-2 approval of T2K-II with revised request of 4-month per year until 2026 when Hyper-K starts to operate. It will yield a total of 10×10^{21} POT collected with the projected power upgrade scenario. Note that the beam upgrade project is already granted stage-2 approval.

The status of the ND280 upgrade was presented and the PAC recognizes the significant R&D and on-going construction activity. We learned that the performance of the prototypes has met or exceeded the design requirements. The construction method for the Super-FGD is now established and beam-tests at CERN and LANL have been carried out. The project timescale shown included known COVID-19 delays. Assembly in the basket will be completed in September 2022 and the detector will be ready for beam by Fall 2022.

PAC also heard a report from the ND280UG review committee, which included 2 members from the J-PARC PAC. The report revalidates the importance of the ND280 upgrade and its physics impact, emphasizing that the possible neutron measurement will enhance its capability. Substantial progress of prototyping and re-optimization of the construction schedule set to September 2022 is reasonable.

The PAC congratulates T2K on their exciting results and looks forward to hearing updated results. The PAC also congratulates recent stimulated efforts for ND280 upgrade construction against COVID-19 situation and found so far, no showstopper for its completion on time.

For the current fiscal year (2020), T2K requested 4×10^{20} POT (52 days). The PAC recognizes the importance of having sufficient beam time for assessing the performance of SK-Gd and the new WAGASCI/Baby-MIND detector before the long shutdown. This exercise ensures that these detector elements will be ready to take full advantage of the increased intensity of the neutrino beam shortly after the accelerator is upgraded. Given the severe limitation placed on running time before the shutdown, the PAC recommends provisionally to assign 1 cycle to FX running in FY2020 and have additional running in FY2021, if significant running beyond 1.5 cycles currently estimated for FY2021 can be realized.

In the longer term (after the long shutdown), the experiment requested 10×10^{21} POT for T2K-II (4 months per year until Hyper-K starts in 2027). This amount of beam time will enable the experiment to continue to obtain world-leading results in neutrino physics until Hyper-K comes online. The PAC notes that 4-months per year is close to the limit of operation for the past 10 years at J-PARC and that the budget situation in future is, of course, not guaranteed. The PAC recommends stage-2 approval with a strong request for budgets that fulfill all the requested beam time to realize the scientific goals of T2K-II and the full J-PARC physics program.

E21(COMET)

The purpose of the COMET experiment is to search for new physics by observing charged lepton flavor violation through μ to e transitions using the new beam line (C-line) in the hadron experimental hall. The COMET experiment aims for a single-event sensitivity of order 10^{-15} in the Phase-I configuration.

The collaboration is still expanding with the addition of new institutes. They have appointed the present spokesperson and the project manager for another term, and a new collaboration board chair to push activities forward.

The PAC is pleased to know the detector components as well as the facility equipment are being built steadily. For the Pion Capture Solenoid (PCS), the construction contract has been signed with the company; it will be delivered in 2022. The CDC of the CyDet is being tested using cosmic rays with full DAQ electronics including slow control and monitors. The design work of the StrEcal is in progress and will be finalized by this summer. On the software side, Monte Carlo (MC) production and development of analysis tools are also in good shape. The COMET group is planning to produce a large MC sample (MC5) this year. The background from cosmic rays has been studied by introducing a new analysis method.

In the present schedule, the C-line construction will be completed by March 2022. Regarding the components of the COMET facility, the muon transport solenoid (MTS) will be tested around the end of 2021 and the PCS will be ready in summer 2023. The detector components CyDet and StrEcal will be ready by September and March 2022, respectively.

The COMET collaboration requests a 15-day beam operation (Phase-α) in late 2022 before the PCS is installed in the beam line. In this test, 8-GeV operation of the MR, slow extraction to the C-line and beam delivery to the COMET apparatus will be studied. Placed in the space reserved for the PCS, additional beam diagnostic devices and extinction measurement detectors will be set up. This allows the COMET group to measure the extinction factor at the target position and to estimate the backward-going pion/muon production rate. This could be an early feedback to the upgraded MR and C-line operations.

The PAC recognizes the Phase-α request is reasonable and important. The PAC asks the COMET collaboration to examine the proposed study items further and to give more information related to a possible impact on the whole schedule toward the start of data-taking. The COMET collaboration is requested to deliver a report on these topics in the coming PAC meeting.

E34(g-2/EDM)

E34 is an experiment aiming to measure the magnetic and electric dipole moments of the muon, using a different method (and therefore having independent systematics) than the completed BNL and the ongoing FNAL experiment. The theory community has recently reached a consensus on the Standard Model prediction of the anomalous magnetic moment, published in a white paper, exhibiting a 3.7σ tension with the data. Since the moments are highly sensitive to New Physics contributions, a clarification of the experimental situation is of utmost importance.

During the PAC meeting the collaboration reported on the status of the H-line construction and the development of experimental components (acceleration, beam diagnosis, injection, field monitoring, detector, analysis software). The completion of the minimum H-line construction is expected in 2020, in order to have first H-line beam in FY2021. They reported some expansion of their collaboration and now include members from India.

The PAC looks forward to reports on critical R&D progress.

P79 (I=3 Dibaryon)

QCD still presents a number of mysteries, prime among them being the existence or otherwise of hadrons with more than three quarks or a quark anti-quark pair. There is evidence in pion-deuteron scattering of a state with isospin one and spin two (D_{12}) at around the sum of the nucleon and Delta masses. As this is the channel with the strongest pion rescattering in the pion-deuteron system it is unclear whether this is a state of two separate three-quark hadrons or an exotic 6-quark system. It is important to check experimentally whether there are other resonances in the six light-quark system. That is the motivation for this experiment, which aims to look for a state with isospin 3 and spin 0, the D_{30} for which there are hints in earlier experiments, for example at WASA-COSY in Jülich.

On the theoretical side there is a very old (pre-QCD) calculation suggesting a state with these quantum numbers at 2.35 GeV. This agrees with a more recent calculation based upon hadron degrees of freedom. On the other hand, QCD based calculations tend to yield a mass nearer to 2.7 GeV for an exotic six-quark state (as opposed to molecular). This difference provides additional motivation for the measurement.

This proposal aims to measure the production of two protons with two negative and two positive pions in proton-proton collisions at 5 momenta covering the invariant mass range 2.2 to 2.8 GeV for the $pp\pi^+\pi^+$ system. The E50 spectrometer with its large acceptance is crucial to the success of the measurement. Perhaps the most challenging aspect of the experiment is the large background to signal ratio shown in Fig. 11 in their proposal. The proposal to improve this situation by focusing on the ^{2}He $\pi^+\pi^+$ decay channel seems promising, although the event rate is much lower.

The PAC is pleased to find that the E50 spectrometer is efficiently utilized also in the hadron resonance search in the non-charm sector as well. The PAC recommends that P79 should proceed further with the preparation. Since there is a possibility that D_{30} is not observed as a narrow resonance, as a bound state of $\Delta\Delta$, it would be helpful to simultaneously measure other observables. The PAC would appreciate a more modern discussion of the motivation for the experiment, clarifying how it might distinguish between molecular states as opposed to exotic multi-quark states. A much more detailed study of the critical signal to noise issue would be appreciated. This should also address the possibility that the mass might be significantly higher and the width substantial.

P80 (Light Kaonic Nuclei)

The P80 is a new proposal of the experiment on light kaonic nuclei, such as *KN*, *KNN*, *KNNN* and *KNNNNN*. This proposal is based on the success of the E15 experiment, which observed *K-pp* nuclei at $E+i\Gamma/2$ = -40+*i*100/2 MeV. The P80 aims to extend the scope of E15 to other light kaonic nuclei.

As the first step, the P80 aims to observe $K^{-}ppn$ ($^{3}_{K}$He) in the reaction of ^{4}He(K^{-},Λ*d*)*n* and $^{4}He(K^{-},\Lambda pn)n$, by using the Cylindrical Detector System, which will be constructed. By observing Λd and choosing the events whose missing mass is equivalent to the neutron mass, one can confirm that the above reaction takes place without directly measuring the neutron. Then it becomes possible to use the original beamline design of K1.8BR, where the beamline is shorter by 2.5 m. As a result, the kaon yield is increased by 1.4 (1.7) times at 1.0 (0.7) GeV/c.

The PAC would like to encourage the collaboration to work with theoretical groups to provide more detailed studies of signals and backgrounds, including differential cross sections for processes involving the formation of Σ^{*} hyperons. It would be helpful to have a more detailed explanation of how this proposal will improve upon the results of E15.

The PAC was concerned about the number of personnel associated with the experiment and would like to encourage the proponents to expand the number of researchers involved. It is important that the group should work with laboratory management to make a serious investigation of the proposed changes to the beam line, including realistic assessments of feasibility and cost.

T77/P73 (Test for $^{3}_{\Lambda}$H Decay)

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

Previously, the PAC suggested to carry out a pilot run (T77) with a ^{4}He target in order to understand the possible background. During the present PAC meeting, the collaboration presented a preliminary analysis of the T77 pilot run data, which was taken in June 2020 with 3 days of running. They showed an impressive π^{-} momentum spectrum plot with a world record of about 1200 clearly identified $^{4}{}_{\Lambda}H$ events and low background. They also presented a very preliminary plot of the decay time distribution. While the systematic errors still need to be evaluated, the new data from T77 suggests that the $^{4}{}_{\Lambda}H$ lifetime can be determined with a statistical precision of the order of 10 ps.

Based on this successful test, P73 now requests stage-1 status. In addition, they ask for a pilot run with the ^{3}He target with 350kW×day before the long shut down in 2021. The aim of this pilot run is to determine the unknown production cross section of $^{3}{}_{\Lambda}H$ with the ^{3}He target. This will then allow them to make an informed estimate of the total beam time which is required for the final physics run.

The PAC congratulates the collaboration for this excellent interim result of T77, which proves that this new experimental method works. The PAC realizes the importance of the pilot run with ^{3}He. Therefore, the PAC supports the continuation of T77 by an explorative run with the ^{3}He target. If the opportunity arises, the ^{3}He data should be taken already before the long shutdown. The PAC also suggests stage-1 status for P73.

Comment on P74: Like the P73 experiment, the P74 collaboration also proposed a direct measurement of the hypertriton lifetime at PAC 28. The P74 collaboration proposes to use the $^{3,4}He(\pi^{-},K^{0})^{3,4}{}_{\Lambda}H$ reaction to produce this lightest hypernucleus. As in the case of P73, the hypertriton lifetime would be determined from the decay time distribution. While P74 proposal has many merits, given the readiness of P73, and additional setup in the K1.1 beamline required for P74, PAC recommends that P74 not proceed to stage-1 status, at least with its present proposed scope.

E03 (X-ray from Ξ^{-} Atom)

The aim of stage 1 of E03 is to observe the n=7 to 6 transition in a Ξ^{-} atom. It should also be possible to have a first look at the n = 6 to 5 transition, where a significant strong shift is expected. If the width of the n = 5 level is sufficiently small (< 1 keV) it may even be possible to get a first measurement of the strong shift and width. This is a very important measurement in terms of studying the Ξ-nucleus force.

The Ξ atom will be formed by producing a Ξ^- through the Fe(K^-,K^+) reaction, which is then captured by another Fe nucleus. The group has made good progress and expects to be ready in December 2020 for a production run on K1.8 in JFY2020-21.

The PAC was impressed by the progress made by the collaboration and recommends that E03 be awarded 19.5 plus 3 days of beam time before the long shutdown in order to complete phase 1 of the experiment.

E16 (Spectral Change of Vector Mesons in Nuclei)

J-PARC E16 will measure the spectral change of vector mesons in nuclei with the e^+e^- decay channel, using 30-GeV primary proton beam to confirm the observation by E325 and obtain more precise information of the spectral change of vector mesons in dense nuclear matter.

The PAC is happy to hear that the new B-line was successfully constructed, and the commissioning went well. Then the first 160 hours (Run-0a) out of the 320 hours beamtime for the E16 commissioning run (Run-0) approved in PAC-24 were executed this June.

The time structure of the beam spill has been improved during the commissioning but needs to be further improved in the next run. The Run-0a was performed successfully with 6 SSD + 6 GTR + 4 HBD + 6 LG setup. These detectors worked under the designed beam intensity 1×10^{10} protons/spill. But the single rates of the detectors were found to be twice more than expected. The group is planning to study this problem in cooperation with the Hadron beamline group.

The E16 group requests 160 hours + additional 24 hours (detector setup again) in the next beam time (Jan. 2021-). The PAC recommends them to take this beam time to complete the commissioning of all the detectors including tracking devices. The PAC also encourages the E16 group to make every effort to study the beam-related problems and the detector performance, including track reconstruction, before the next beam time.

E42 (H dibaryon)

The E42 experiment aims to identify the H-dibaryon, S=-2 and B=2 six-quark state (*uuddss*), in the $^{12}C(K^-, K^+)H$ reaction at K1.8. Measurements of the ΛΛ, $\Lambda p\pi^-$ and $\Xi^- p$ final states with 1MeVgood mass resolution, high sensitivity and wide H mass range, will provide key information on the elusive H-dibaryon. Compared to heavy-ion collision experiments, the signal from the interaction can be larger because of the small source size and enhanced yield at small relative momenta.

The E42 hyperon spectrometer consists of a time projection chamber (HypTPC) and a super-conducting Helmholtz magnet. In this PAC meeting, the E42 reported the progress of preparation in the backup slide and answered several questions raised by the referees. At the presentation, the proponent explained the beam time request; 36 days of the E42 beamtime including 0.5 days for the trigger study with water Cerenkov detectors at the end of the E03 run, 4.5 days for beam commissioning in April, and 31 days of the physics run at 50 kW in May and June, 2021. The PAC is pleased to see that E42 will be ready and recommends that the data be taken before the long shutdown.

4. GERAL REMARKS AND RECOMMENDATIONS

The committee was impressed with the remarkable news that, despite the challenging environment since March 2020, J-PARC has made good progress in all areas. The FX operation at >500 kW has been established in January. The new target for, eventually, >80 kW operation in the Hadron Hall has been installed successfully and is operating at 50 kW. The new beamline, B line, has been commissioned, transporting the 30 GeV primary proton beam. Since May, MLF has been receiving ~600 kW beam power routinely from RCS, and up to 1 MW is possible.

We heard at the last PAC meeting the exciting news about the start of the Hyper-K project. This time we heard that the 10-year J-PARC plan that includes the Hadron Hall extension, COMET-II and g-2/EDM has been selected as one of the 31 important projects by the Science Council of Japan (SCJ). The T2K collaboration has published a highly significant paper on the measurement of the CP violating phase in Nature.

The committee congratulates J-PARC and KEK on their accomplishments, especially on what they have accomplished during a very difficult period due to the continuing COVID-19 pandemic. The committee would also like to congratulate Prof. Ichikawa on winning the Saruhashi Prize.

There has been a delay of 3 months for SX operation due to a delay in getting permission from the Nuclear Regulation Authority. While the length of the spring SX running was not impacted, the Long Shutdown is delayed by 3 months. The COMET beamline is now not expected to be ready until Winter of JFY2022, rather than the end of JFY2021.

We were concerned that the financial situation for JFY2020 running has not improved and that only 2 more cycles could operate in this FY. There may be another 1.5 cycles of running in JFY2021, for a total of up to 3.5 cycles of running before the long shutdown which is now scheduled to begin in July 2021. The running schedule till the long shutdown is severely constrained by funding.

After consideration, we recommend that E03 finish their data taking in the Hadron Hall, after which the detector needs to be reconfigured. During the 3 months for re-configurating the E03 detector, FX can provide 1 cycle of running to T2K for validation of Gd doping of SK. Subsequently data taking of E42 should be finished in the Hadron Hall, so that the major upgrade of the detector can be carried out during the long shutdown. J-PARC should also find time to deliver the 6 days of 8 GeV beam tests for COMET. If there is an opportunity for a small increase of beamtime before the long shutdown, the P73/T77 test for ^{3}He for 5 days could be scheduled. If there is a significant extension of ~1 cycle or more, then further FX running for T2K is recommended.

The committee was pleased to hear that there has been a lengthy discussion between the neutrino community and KEK with the outcome that KEK will make the best efforts to provide 4 cycles/year of data taking for T2K-II. PAC considers that this would be appropriate, giving the needed data required for attaining significant results up to the start of the Hyper-K program. Indeed, the committee recommends the phase-2 approval of T2K-II at this time.

At the same time, the committee is concerned that the operation budget at J-PARC for the past decade has rarely allowed operation at above 5 cycles/year and quite often at or below 4 cycles/year. It is understood that the lack of beam time in the past few years was the result of lab’s decision to invest on the new power supplies for Main Ring, which will be beneficial for both future FX and SX running. The Hadron Hall program, however, has already developed a very large backlog and requires a similar level of beam-time as the T2K-II program after the long shutdown. As we have pointed out in the past, continued unavailability of beam time at J-PARC for the approved experiments will have a chilling effect on the vibrancy of the J-PARC community both domestically and internationally; it will do irreparable harm to the J-PARC program and tarnish the global reputation. Furthermore, in view of the fact that SCJ has chosen the long-term plan of J-PARC as a top national program, it is vital to secure sufficient beam-time for both the Hadron Program and the Neutrino program. Given that FX and SX runnings remain mutually exclusive, this issue can only become more critical in the Hyper-K era, even with the planned beam power upgrades. We reiterate the need for beam time of at least 6 months per year during the period of upgrades towards 1.3 MW and to the full 9 months per year afterwards. While technical solutions to allow simultaneous FX and SX operations appear challenging, they should also be pursued.

The committee reiterates the congratulations to J-PARC and KEK for the successful operation of the laboratory and its projects during this difficult time of the global pandemic. Most experiments reported, so far, relatively small impact of COVID-19. The upgrade plans seem to be relatively unaffected so far. Given the unpredictable nature of the situation, however, we urge caution and forward planning whenever possible.

5. DATES FOR THE NEXT J-PARC PAC MEETING

The next J-PARC PAC meeting will be held January 20-22, 2021.

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

- Minutes of the 29th J-PARC PAC meeting held on 16-18 January, 2020 (KEK/J-PARC-PAC 2020-4)
- Proposals:
    - Proposal for 8GeV Operation Test and Extinction Measurement (KEK/J-PARC-PAC 2020-6)
    - Search for an I=3 dibaryon resonance (KEK/J-PARC-PAC 2020-9)
    - Systematic investigation of the light kaonic nuclei (KEK/J-PARC-PAC 2020-10)

- Technical Design Report:
  - ND280 Upgrade (KEK/J-PARC-PAC 2020-5)
- Reports:
  - Final Comments from the Review Committee for the T2K ND280 Upgrade Project (KEK/J-PARC-PAC 2020-11)
- Letter of Intent
  - Search for sub-millicharged particles at J-PARC (KEK/J-PARC-PAC 2020-7)
  - Measurement of the cross section of the Λp scattering (KEK/J-PARC-PAC 2020-8)