To be approved at the 27th PAC meeting
KEK/J-PARC-PAC 2018-XX
Aug. 9, 2018

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

Minutes of the 26th meeting held
18(Wed.)-20(Fri.) July 2018

OPEN SESSION:

1. Welcome and Mandate to the Committee: K. Tokushuku (KEK)
2. J-PARC Center Report: N. Saito (J-PARC/KEK)
3. J-PARC Accelerator Status & Plan: F. Naito (J-PARC/KEK)
4. Report from the Neutrino Beam Line Review Panel K. Tanaka (J-PARC/KEK)
5. T2K(E11) /T2K-II (E65) Status and Plan 1
   — Overview, Analysis Status, and Plan — K. Mahn (Michigan State)
6. T2K (E11)/T2K-II (E65) Status and Plan 2
   — Status Report and Beam Request — T. Nakadaira (J-PARC/KEK)
7. E34(g-2/EDM): T. Mibe (J-PARC/KEK)
8. E61(NuPRISM/TITUS): M. Hartz (IPMU)
9. E56 (Sterile Neutrino Search): T. Maruyama (J-PARC/KEK)
10. E14 (KOTO): T. Yamanaka (Osaka)
11. E40 (Measurement of the Cross Sections of Σp Scattering):
    K. Miwa (Tohoku)
12. P73 ($^{3}_{\Lambda}H$ and $^{3}_{\Lambda}H$ Mesonic Weak Decay Lifetime Measurement with $^{3,4}He(K^-,\pi^0)^{3,4}_{\Lambda}H$ Reaction): Y. Ma (RIKEN)
13. FIFC Report: S. Uno (KEK)
14. E69 (WAGASHI/BabyMIND): A. Minamino (Yokohama)
15. E71 (NINJA): T. Fukuda (Nagoya)
16. E21(COMET): Y. Kuno (Osaka)

17. Hadron Hall & SX Beam Status, Schedule and Target R&D Plan:
H. Takahashi (J-PARC/KEK)

18. E45 (Baryonic spectroscopy with 3-Body Hadronic Reaction) :
K. Hicks (Ohio)

19. E36 (Lepton Universality): S. Shimizu (Osaka)

20. E03 (Measurement of X-ray from Ξ^- Atom): K. Tanida (JAEA)

21. E07 (Double Strangeness): J. Yoshida (JAEA)

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

23. E62 (Precision Spectroscopy of Kaonic Atom X-rays with TES):
S. Okada (RIKEN)

24. E57 (Strong Interaction Induced Shift and Width of Kaonic Deuterium):
J. Zmeskal (SMI-OeAW)

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

CLOSED SESSION:

Present: N. Aoi (Osaka/RCNP), M. Blanke (KIT), S. I. Eidelman (BINP),
J. Haba (KEK), K. Hanagaki (KEK/Osaka), D. Harris (FNAL, via network),
Y. Itow (Nagoya), F. Le Diberder (CNS/IP2N3/LAL),
A. Ohnishi (Kyoto/YITP), S. Kettell (BNL), R. Kitano (KEK),
M. Kuze (Tokyo Inst. of Tech.), J. Pochodzalla (Mainz),
W. Weise (TU Munich), H. Tamura (Tohoku), A. W. Thomas (Adelaide),
R. Yoshida (Chair, JLab), W.A. Zajc (Columbia),
K. Tokushuku (KEK-IPNS Director),
T. Kobayashi (KEK-IPNS Deputy Director) and N. Saito (J-PARC Director)

1. PROCEDURAL REPORT

The minutes of the 25th J-PARC-PAC meeting (KEK/J-PARC-PAC 2018-14) were approved.

2. LABORATORY REPORT

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

The director of the Institute of Particle and Nuclear Studies (IPNS), Katsuo Tokushuku, welcomed the PAC members. Tokushuku reported on the renewal of the committee membership and assigned Rik Yoshida as the new chairperson of the Program Advisory Committee for the Nuclear and Particle Physics Experiments at the J-PARC Main Ring (MR).

As an introduction of KEK-IPNS, he reported selected topics from recent activities, in particular, the success of the first electron-positron collision recorded by the Belle II detector during SuperKEKB commissioning in April 2018. He described the J-PARC history along with the beam power development of the MR. In the spring 2018, the machine recorded the highest power of 504 kW during a short test period at the fast extraction (FX) and was operated stably at 51 kW for experiments in the Hadron Hall in the slow extraction (SX) mode.

Tokushuku explained the progress of the experiments in the Hadron Hall in 2017-2018; an experiment searching for double-Lambda hyper-nucleus using nuclear emulsion plates (E07) was completed in 2017 at the K1.8 beam line, followed by a hyperon-proton scattering experiment (E40). At the K1.8BR beam line, a study of hyperon resonance (E31) has been completed. Then two Kaonic atom X-ray measurements (E62/E57) were in the beam line. E62 completed successfully in June 2018. At the KL beam line, KOTO(E14) continues physics data acquisition and plans a detector upgrade for further improvements of the background rejection. A construction of new beamlines to provide the primary proton beam for E16 and 8-GeV primary proton beam for COMET is in progress.

Tokushuku reminded the committee members of the general mandates and the approval process of proposals. Then he presented a summary of on-going experiments and proposals. He reported that one new proposal and one LOI have been submitted to this PAC meeting and showed a list of TDR's for stage-2 approval requests submitted from E45, E56, E34, E69, and E71 experiments.

The KEK long-term plan was also explained; KEK has settled on a Project Implementation Plan (PIP) in 2016, stating that the highest priority are on the stable operation with sufficient running time of the three major on-going projects (J-PARC, SuperKEKB, and Photon Factory). As for J-PARC, the following upgrades are to be covered by the current yearly budget; construction of COMET Phase-I, reinforcement of the facilities for T2K, neutron polarization project at MLF, construction of the central portion of the MLF muon H-line, and completion of the high-momentum beam line in the Hadron Hall. PIP also states that the KEK "future" projects that require extra funding resource have the following priority; 1) upgrade of J-PARC MR for the Hyper-K project, 2) Particle Physics Program in HL-LHC/ATLAS, 3) construction of MLF muon beam H-line and g-2/EDM experiment, 4) extension of the J-PARC Hadron Experimental Facility.

For the stable operation of the J-PARC with improved performance, the short term priority is on the upgrade of the MR power supply and a new Hadron Hall primary target for receiving beam power larger than 80 kW. Tokushuku explained the Mid-term plan of MR update settled in March 2018 with a conservative funding scenario.

Tokushuku summarized his presentation by showing a guideline for PAC discussion as follows;

- No MR beam before Feb. 2019 since two major experiments (T2K, KOTO) are not able to take data in this period.
- From April to June 2019, full operation (either SX and FX mode) is assumed to be possible although it depends on the FY2019 budget.
- After 2019 summer, no beam is available for SX before Jan. 2020 due to the primary target replacement.

He requested the PAC to discuss the beam time schedule until summer 2019 based on this condition.

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

The J-PARC Director, Naohito Saito, welcomed the PAC members. He explained the operation status and beam power history of two accelerators, RCS and MR. Stable user operations at a beam power of 490 kW, 51 kW, and 525 kW were successfully achieved at Neutrino Facility, Hadron Experimental Facility, and MLF, respectively. He also mentioned the successful one-hour test of 1 MW stable operation conducted at MLF. Development status of MLF neutron and muon targets for 1-MW operation was mentioned. Operation of the MLF at 1-MW beam power is critical for the Sterile Neutrino Search JSNS^2 (E56) and Muon g-2/EDM (E34) to achieve their target sensitivities within their scheduled time line.

Saito mentioned the MR plan beyond 1-MW operation anticipated after magnet power supply and relevant upgrades, for which J-PARC has formed a consensus with IPNS, IMSS, and Accelerator Laboratory directors to invest the necessary resources by managing the available budget. Details of the J-PARC action plan in FY2018 were shown; safe and stable operation of the facilities should be maintained while increasing the beam power, continuing preparations for future projects and increasing scientific outputs.

Before closing his presentation, Saito explained the MEXT Review, which assessed the J-PARC project in June 2018 after six years since the last review, as well as the new exercise of Japan Science Council (JSC) Master Plan likely to start. In 2017, JSC selected 28 proposals as important projects, among which (1) Elucidation of the origin of matter with an upgrade of the J-PARC experimental facility (2) Nucleon Decay and

Neutrino Oscillation Experiment with a Large Advanced Detector (Hyper-Kamiokande) are included.

2-3 J-PARC Accelerator Status (Fujio Naito, J-PARC/KEK)

Fujio Naito summarized the J-PARC accelerator status and plan. First, he explained that there are two operational modes in Main Ring (MR); fast extraction mode (FX) for neutrino experiments and slow extraction mode (SX) for hadron hall experiments. He presented the operation summary since the last PAC held in January 2018. The SX operation was performed in January, February and June while the FX operation was performed from March to the end of May. Stable operation of the MR in SX mode has been established with a beam power of 51kW. As for the MR FX mode, stable operation with a beam power of 485kW as well as continuous 50 shots with 500kW has been established successfully. It should be noted that double-bunch operation with a beam power of 500 kW has been achieved at the RCS to provide proton beam to the MLF. Moreover, 1 hour continuous operation of 1 MW beam to MLF has been successfully carried out on July 3rd. Beam availability of 88.8% has been achieved during the FX operation in FY2017 while the availability during the SX operation was only 65.9% due to problems with SX-ESS (Electro Static Septum) reported in last PAC meeting. The beam availability for the FX and SX operations from April to July 2018 was 86% and 88.2%, respectively. He presented that down time during the FX mode was mainly caused by MR RF failures and oil leakage at the heat exchanger of the transformer used in the FX septum power supply.

Naito showed the status and results of accelerator studies. Intensive studies were carried out in order to increase the beam power and to further improve the beam stability. Accelerator group identified that beam loss in RCS and 3-50BT was caused by the energy fluctuation of 400MeV beam from the LINAC. They introduced a new scheme to compensate the beam energy using the debuncher-2 in L3BT, and confirmed that it works well to keep $\Delta p/p$ less than 0.02% and reduces the beam loss. Working toward higher power operation, the 60 mA beam was successfully accelerated up to 400MeV in the LINAC for the first time on July 4th. RCS studies were carried out for 1MW beam operation. High intensity beam study for MR FX mode was also performed. The beam power of 520kW was achieved in a single shot mode with the beam repetition cycle of 2.48 seconds. This indicates that the beam power can be as large as 1.1MW if the cycle time is reduced to 1.16 seconds while the beam loss would be 1.5kW. Further beam study is necessary to reduce the beam losses to establish the continuous higher beam power operation. The MR group also found that there were longitudinal oscillation and that the RF anode current reached the limit of the power supplies for the 500kW operation. It is an issue to be solved for the stable operation above 500kW power. At the moment they are developing an RF feedback system to damp the longitudinal oscillation. As for the SX mode operation MR study was performed to improve the duty factor by further tuning the transverse RF frequency pattern, resulting in the duty factor improvement from 42.6% to 50.9%. Higher beam power of 62.8kW in the SX mode was also demonstrated. Beam study for MR 8 GeV acceleration and slow extraction toward the COMET experiment was also performed successfully. Further studies will

continue in order to understand the proton leakage observed in the K4 rear bunch position in the 1st 100 milliseconds during beam extraction.

Naito reported the status of MR power-supply upgrade. Construction of three dedicated buildings for new power supplies has been completed. New power supplies and capacitor banks for them are already installed in some of the buildings. Commissioning of new power supply is in progress. He showed the mid-term plan of the MR. The repetition cycle of MR operation will be shortened from 2.48 seconds to 1.32 seconds for the FX mode after completing installation of the new power supplies in 2021.

Naito concluded his presentation by showing a tentative operation schedule of the MR in the first half of FY2019 (January to July) with accelerator study plans for both FX and SY modes.

2-4 Report from the Neutrino Beam Line Review Panel (Kazuhiro Tanaka, J-PARC/KEK)

Kazuhiro Tanaka reported the outcome from the Neutrino Beam Line Review Panel. Details are described in the review report［KEK/J-PARC-PAC 2018-26］. Further comments are in Sec 3.

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

Shoji Uno presented a report from the Facilities Impact and Finance Committee (FIFC). He reported on the meeting held on June 27th, 2018 at Tsukuba campus. FIFC discussed the feasibility of E45, E69 and E71 where all of the experiments are requesting stage-2 approval based on TDR. New reviewer, Yasuhiro Sugimoto(KEK), jointed from this meeting instead of Junji Haba(KEK). Rik Yoshida (J-Lab.), the new chairperson of J-PARC PAC, was invited as an observer.

Uno first explained the review results of E45 experiment. The purpose of the E45 experiment is to measure the decay of N* resonances through the $\pi N \rightarrow \pi\pi N$ reactions at the K1.8 beam line. The E45 experiment had been reviewed in the previous FIFC meeting. In the June meeting, the experimental group reported on all of the issues which are described in the previous report, and those responses satisfied the committee, on the whole. Uno showed some of examples of the responses from the experimental group. The first example is the design of the installation tool of the liquid H_2 target into the TPC, which was a missing item of the previous TDR. The design and the detailed procedure for the installation shown by the experimental group are satisfactory. The second example is the design of the segmented TPC hodoscope in the forward region as recommended previously. The better quench protection system in the superconducting magnet was also conducted as recommended. Uno explained that one remaining issue of E45 was the results of the beam test, which is expected to be presented in this PAC meeting.

Uno discussed the review results of E69(WAGASCI/Baby-MIND) experiment next. The purpose of the E69 is to measure the differential cross section of the neutrino and anti-neutrino interaction with nuclei in a water target at around 1GeV neutrino energy. Uno explained that the fine-grained detectors with/without water (WAGASCI detector) have been extensively tested since 2016 as a test experiment, T69. The Baby MIND muon detector has been tested with beam at CERN in 2017, and it was already installed in Feb. 2018 and tested in the NM hall. Functionality of those detectors has been examined and verified. FIFC concluded that there was no serious technical issue remaining. E69 group has also merged with the T2K collaboration already and FIFC expects communication and coordination will become easier. FIFC expects that the achievability of the physics goal of E69, which was not so clear in the June FIFC meeting, will be discussed in this PAC meeting.

Uno finally presented the review results of E71(NINJA) experiment. The purpose of E71 is also to measure the neutrino interaction with nuclei for the water target to reduce the systematic uncertainties of the T2K experiment. In particular, E71 will measure the contribution from 2 nucleon interaction (2p2h) using the emulsion technique. FIFC reviewed and concluded that there is no serious technical issue on E71 experimental apparatus, which is an emulsion cloud chamber in combination with other detectors. FIFC expects that the achievability of the physics goal of E71, which was not so clear in June FIFC meeting, will be discussed in this PAC meeting.

Discussions at the FIFC meeting are summarized in detail in a separate report.

2-6 Hadron Hall & SX Beam Status and Target R&D Plan (Hitoshi Takahashi, J-PARC/KEK)

Hitoshi Takahashi reported on the status and schedule of the Hadron Experimental Facility. The report included the status of recent beam delivery, construction of the high-p/COMET beam lines, and R&D status of the new production target (T1 target).

Takahashi showed the integrated beam power history during the last two cycles of beam time. In the run from January to February, 2018, about 93% of the planned beam accumulation was achieved. The E31 experiment was conducted and the first 8-GeV extraction test was performed for COMET during the beam time. In the June run, 90% of the planned beam was accumulated, and the E62 experiment was conducted. The accumulated beam power was 1010 kW*days and 1075 kW*days in these periods, respectively.

An upgrade plan for the T1 target was reported. The next target will be an indirectly water-cooled type, which is capable of accepting primary beam power of up to 90 kW. It is now being manufactured and the installation is planned in fall 2019. Furthermore, another type of target, a rotating target operated with direct cooling with water or He gas, is being developed for the future. This is called a “euro-coin” type target composed of a nickel disk with a gold or platinum edge. The status of the R&D works for this type of target was reported.

Construction work for the high-p/COMET beam lines is in progress. Within this year, installation of magnets in the branching section and high-p experimental area will be completed. Takahashi showed the construction schedule of the high-p beam line. The beam line is expected to become available in winter JFY2019.

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

E11/E65 (T2K and T2K-II)

The committee heard two talks from the T2K collaboration followed by a report from the neutrino beam line upgrade technical advisory committee.

The first talk reported on the 2018 T2K result based on Run9c with 2.62e21 POT in total (1.49e21 and 1.12e21 for nu-mode and anti-nu-mode, respectively), which were presented in Neutrino2018. Note that Run9d data will be added late summer to increase nue-bar POT from 1.12e21 to 1.63e21 POT.

T2K precision result on theta_23 continues to prefer maximal mixing, while the result NOvA showed at Neutrino 2018 shows a slight preference for the second octant. T2K sensitivity with doubled statistics for NOvA's best-fit point was shown. As for nue-bar appearance, 6.5 background events are expected for no oscillations, while 9 events were observed. No statement can yet be made given the limited statistics.

The data fit with a reactor constraint finds that a CP-conserving value of delta is outside of a 2-sigma band for both hierarchies, while the normal neutrino mass hierarchy is weakly favored. There is a slight tension with the NOvA 2018 result on nue-bar appearance with 18 events observed while 5.3 background events are expected. There was a discussion with committee members about CC1pi fluctuation in nue appearance and there was a discussion of the checks currently underway in the same CC1pi channel in numu disappearance. The committee also heard about the exotic heavy lepton search and many neutrino interaction measurements. The latter of which, to be measured by E61, E69 and E71, would be important for further improvement of systematic uncertainties in the oscillation analysis.

In response to the previous PAC meeting recommendation, T2K gave a summary of the complementarity of the NINJA, WAGASCI, ND280-upgrade and E61 efforts to reduce systematic uncertainties. The committee urges T2K collaboration to consider making a quantitative evaluation of the impact of the proposed measurements to future T2K results. This may include differential cross sections or measurements as a function of some kinematic variable that is not specifically mentioned in the current proposals. This will help the measurement proponents to better specify the statistical and systematic uncertainty goals, and in turn to help the laboratory in understanding the running needs.

The second talk focused on T2K's running status and future plan.

A total of 9e20 POT was requested for 2018 as Run9 (Oct2017-2018). 9.1e20 POT was achieved in 131 days allocated. The accelerator complex operators are to be congratulated on delivering more than the requested POT. There is a water leak of 7 liters/day in the cooling system. The leak is somewhere in the He vessel from a horn, most likely horn1, but the precise location has yet to be determined. Horn replacement can start this Nov 2018 at the earliest and would be ready for neutrino beam by end of Feb 2019, if needed. If the He vessel is confirmed not to be damaged, then the beam operation can continue until 2019 summer shutdown and the leak repaired afterwards.

The problems with the ND280 magnet that started in March led to substantial down time, but were fixed by May 3. There is a concern that the low ND280 livetime will be a problem, and PAC would like to hear more about a plan to address this issue.

Impact of SK-Gd plan and its schedule was discussed. Currently Super-K is offline for preparation work of SK-Gd until end of 2018. There will be a 3-step approach for Gd-loading;

step-1 preparation for water system (2019Apr-Jun),

step-2 A 3-months period for circulation of pure water using the Gd-water system,

step-3 actual Gd injection, lasting 3-months, after 2019 Oct.

Super-K prefers successive step-2 and step-3, and needs step-3 within JFY2019.

Finally the committee heard a report for Neutrino beam line upgrade technical advisory held in June 21-22 (see Sec 2-4). After feedback from T2K response, the final report will be delivered to the director by the end of July. Similarly, the ND280 upgrade also needs a focused review. The PAC endorses the recommendations that were presented on the beamline upgrade review.

T2K indicates a long-term plan to double the statistics before MR power supply upgrade planned in JFY2021. The PAC suggests an update of the expected cumulative POT vs date according to the new plan. T2K requests 7.5e20 POT in the first half of 2019, in view of the rapidly changing statistics in NOvA. The committee recognizes the urgency of this request. Given the current constraints of the beam time availability, however, allocated beam time might be significantly reduced compared with the requested beam time. The PAC recommends the laboratory management to explore options to restore the beam time.

E34 (g-2/EDM)

The E34 (g-2) experiment aims to measure the anomalous magnetic moment (g-2) and electric dipole moment of the muon.

E34 reported progress in many areas. The g-2 theory initiative has reported progress on improving the hadronic vacuum polarization and light-by-light scattering contributions

and expects to produce a white paper in early 2019. The improved collaboration organization was shown and is reported to be functioning. The building for the necessary power for g-2 is being constructed in FY2018. The various steps in the acceleration of the bright muon beam have been demonstrated to 90 keV (with an article in the CERN Courier and with several papers published including three in 2018). The next step is to demonstrate acceleration to 1 MeV. The collaboration plans to publish a TDR summary on the experiment design.

g-2 requests stage-2 approval.

The updated TDR and responses to the recommendations by the PAC and Focused Review Committee (FRC) were reviewed by the FRC. A report from the FRC has been given to the PAC recommending stage-2 approval. The PAC suggests that g-2 work with Lab management to refine the cost estimate and schedule.

Following the recommendation of the FRC, recognizing the tremendous progress by the g-2 collaboration and plans for addressing remaining issues the PAC recommends stage-2 approval.

E61 (NuPRISM/TITUS)

E61 is a proposal to build a ~1kt intermediate water Cherenkov detector to be used to study neutrino interactions at various off-axis angles in the T2K neutrino beam line. The committee heard progress of phase-1 site investigation. Several candidate sites were found and discussed. From event rate consideration, the closest site has 0.21 for efficiency at most on-axis due to pile-up with OD veto, but is still acceptable. Committee heard also update design for lifting structure and mutli-PMT type photo-sensors. E61 is working closely with the Hyper-Kamiokande collaboration and trying to integrate as a part of Hyper-K near/intermediate detectors. The committee encourages E61 to continue the site survey and design work.

E56 (Sterile Neutrino Search)

The JSNS2 experiment (E56) plans to search for eV scale sterile neutrinos using a stopped muon source significantly improved compared to that used by LSND.

JSNS2 reported significant progress. They showed a schedule for detector construction in JFY2018 with operation in early JFY2019. They moved the stainless steel tank along a route similar to the proposed annual movement of the detector with no problems encountered. The tank has been cleaned and the PMT mounting structures are being installed. PMTs should be available on the same timescale as the inner acrylic tank later in JFY2018. Options for filling the detector, lifting it and satisfying the fire safety laws were discussed with a J-PARC safety working group. Further discussions with regulatory bodies are required.

The collaboration responded to the previous PAC request for a more detailed simulation of the calibration of the detector. While the light yield increases as much as 30% near the edges of the detector, the effective light yield as observed in the resolution of the Michel spectrum declines significantly in these regions. They showed effects from the dead acrylic region, PMT saturation and after-pulsing. They described very general options for calibration sources beyond Michel electrons and n-Gd captures. They showed scintillator quenching data from Daya Bay and JSNS2 simulations that appears to show some discrepancy in the overlap region from 8-10 MeV. The collaboration has taken the first steps toward developing a blind analysis strategy, although significantly more work is required.

JSNS2 requests stage-2 approval.

Given that detector construction is well underway, international partners need full experimental approval and securing funding for the second detector likely requires results from operation of the first detector, and the progress made in understanding systematic effects, the PAC recommends stage-2 approval.

E14 (KOTO)

E14 is an experiment to search for the CP-violating rare decay $K^0_L \to \pi^0 \nu\nu$, whose branching ratio is predicted in the Standard Model (SM) to be 2.4E-11 with small theoretical uncertainty. Because of this good theoretical control, measurements of the branching ratio can explore new physics up to a scale much higher than the TeV energy range, which makes this search one of the most interesting searches for beyond-SM physics. Compared to the last PAC presentation, the collaboration optimized background rejection further and tailored the signal region. The background expectation in the 2015 data set is 0.40±0.18 events, dominated by hadron cluster background. The single-event sensitivity (SES) is 1.3E-9, just below the Grossman-Nir limit inferred from the charged kaon decay. Recently they unblinded the signal box, and found no event in the signal region, giving a 90% CL upper limit of 3E-9, which was presented in the major conferences ICHEP and FPCP this summer.

Concerning the 2016-18 data analysis, most runs have been processed except for the most recent Run 79. The analysis now focuses on the background reduction and estimation. In the 2018 summer shutdown, they will attach MPPCs on the front face of CsI crystals, which should help further reduce the hadron cluster background. This crystal configuration equipped with MPPC was tested with a beam at RCNP. They will also install new charged veto inside the beam pipe.

A projection on the SES has been made with certain assumptions on the background reduction, beam power increase, reduced veto timing width and reduced accidental rate. By 2020 the sensitivity will reach around 1E-10 and by 2028, which is at the level of the SM prediction. They identified possible path to reach this background level. The PAC appreciates seeing these projections and encourages the collaboration to work

together with the lab management to further develop the plan to reach the SM level sensitivity.

The PAC congratulates E14 on the completion of the 2015 data analysis and encourages to publish it as soon as possible. The PAC encourages a focused effort to understand and minimize backgrounds in the 2016-18 data set as soon as possible. The PAC would like to see their readiness to run in 2019 after their summer 2018 upgrade-work and looks forward to a report at the next meeting. The PAC recognizes the uniqueness of the experiment in the search for new physics and the importance of the international collaboration from US, Korea, Russia and Taiwan in pursuing the experiment under higher beam power in coming years.

The collaboration requests 0.5 months of neutron run, and 1.5 months of physics run before summer 2019. The PAC supports this request.

E40 (Σp)

The E40 experiment measures the $\Sigma^{\pm}$p cross section at the K1.8 beam line using the KURAMA spectrometer augmented with a new detector system (CATCH) for scattered protons. Isospin separation will be provided by measurements of $\Sigma^+ + p \rightarrow \Sigma^+ + p$ and $\Sigma^- + p \rightarrow \Sigma^- + p$ along with $\Sigma^- + p \rightarrow \Lambda + n$. These data will be of vital importance to our understanding of nuclear matter at high density relevant to recent and future observations of neutron star mergers.

At the previous PAC meeting, the PAC recommended a minimum of commissioning and initial data taking in the $\Sigma^- + p$ mode during the June 2018 running period. In this PAC meeting, the E40 collaboration reported on the June run. The allocated beam time was 87 hours in total including 2 days of physics data taking. Σ^- particles are clearly identified, and the number of produced Σ^- was 1×10^6 in 2 days. This number is much larger than the total Σ^- observed in KEK E289 experiment, which was 1.8×10^5 in total. By tuning the parameters in SCH (segmented hodoscope), Σ^- number can be increased from 30 Σ^-/spill to 54 Σ^-/spill, close to the designed yield. Commissioning of CATCH is also made, and it is confirmed to work stably.

The PAC considers that the June 2018 run was successful and encouraging. Also the PAC finds that the CLAS collaboration at J-Lab has the capability to analyze Σ^+p reaction in the near future.

The PAC recommends that E40 should take data at the next earliest opportunity given the potential competition with other experiments. Given the current constraints of the beam time availability, allocated beam time might be reduced compared with the requested beam time. The PAC recommends the lab. management to explore the options to restore the beam time.

P73 ($^{3,4}_{\Lambda}H$ Weak Decay Lifetime)

The lightest strange baryonic nuclear system is the hypertriton, $^{3}_{\Lambda}H$. Like the deuterium or the tritium nucleus for conventional baryon interactions, the $^{3}_{\Lambda}H$ provides an important benchmark for any strong interaction theory dealing with strange baryons. Its small Λ binding energy B_Λ of only 130 keV found in emulsion studies implies that the Λ hyperon has a rather extended wave function. Recently, several heavy-ion collision experiments (STAR at RHIC, HypHI at GSI, and ALICE at LHC) reported $^{3}_{\Lambda}H$ lifetime significantly shorter than the free Λ lifetime. The combination of such a short lifetime on one hand and, on the other hand, the small binding energy presents one of the most intriguing puzzles in hypernuclear physics.

P73 aims at a novel precision measurement of the $^{3}_{\Lambda}H$ lifetime which does not rely on the decay vertex distribution as in the recent heavy ion studies. Instead, P73 proposes a direct measurement of the decay time distribution in the $^{3}He(K^-, \pi^0)^{3}_{\Lambda}H$ reaction. The start signal for the measurement of the time delay caused by the weak decay of the hypertriton, is provided by the incoming K^- beam particle, the stop signal is deduced from the tracking and timing information of the π^- emitted in the pionic two-body decay $^{3}_{\Lambda}H \rightarrow {}^{3}He+\pi^-$. The different technique used in this experiment will provide an important result on this topic.

Presently, there are several activities ongoing to provide a more precise value for the hypertriton binding energy. Therefore, the proposed experiment is very timely. The experiment makes use of a Cylindrical Detector System (CDS) and a ^{3}He target system previously used in J-PARC E15/E31 experiments. The setup will be complemented by a hadron-blind calorimeter installed in the very forward region to detect $\pi^0 \rightarrow \gamma\gamma$ decays. The detection of high energy (> 600 MeV) γ-signals from the π^0 decay will indicate the production of a Λ hyperon with small recoil momentum which eventually may form a hypertriton.

In order to proceed to Stage-1 status recommendation, the PAC encourages the P73 collaboration to submit an updated proposal with detailed descriptions of the experiment, including improved Monte Carlo calculations and more details on the setup and analysis method. The beam momentum and the setup (in particular, the position and the size of the target cell and the PbF_2 calorimeter) should be carefully optimized so that the best accuracy is obtained. While the statistical uncertainty of this new lifetime measurement seems to be very competitive, P73 should explain how possible systematic uncertainties can be controlled and to what level they may eventually be eliminated. It should also provide more information on possible background, which may, for example, be caused by K^- decays traversing the detection system.

E69 (WAGASHI/BabyMIND)

The E69 experiment (WAGASCI/BabyMIND) proposes a neutrino interaction measurement on the water and the CH targets in the T2K neutrino beam line. The results will be useful to improve systematic errors due to neutrino interaction

uncertainty in the T2K analysis. The detector consists of the Proton Module and the WAGASCI module, the 3-D Scibar readout planes embedded in the water. The stack of WAGASHI / Proton / WAGASHI modules are followed by BabyMIND magnetized iron muon spectrometer providing muon momentum measurement.

The committee recognized that E69 will be fully integrated into T2K collaboration as one of sub-systems under MOU. This allows analysis coordination under the T2K analysis convener and collaboration responsibility for the operation and maintenance work. The committee appreciated this decision.

The committee heard excellent progress in the pilot experiment T59 for R&D work for each component of E69 detector, MC works and expected improvement for the systematic errors in the T2K oscillation analysis. The committee was convinced that this substantial achievement readies E69 for the real experiment. The committee further asked what was the specific deliverable from E69 and how to measure differential neutrino cross section on the water. The detailed explanation was given in the closed session. The key analysis is the flux subtraction method combining measurements at the two different off-axes of T2K ND280 and E69 both with water and CH targets. The committee found that the method should work reasonably well in the kinematic regions where the acceptances can be made to be similar but encourages further efforts to minimize model dependence in the measurement. The group requests stage-2 approval and neutrino and anti-neutrino beams of one year for each (each for >5e20POT). The committee understood that stage-2 approval is required for massive installation work of the detector in summer 2018. Considering the matureness of the detector preparation, the physics impact on T2K and full integration to the T2K collaboration, the committee recommends stage-2 approval.

E71 (NINJA)

E71 (NINJA) is an experiment to study neutrino-water interactions with an emulsion-water sandwich detector. Thanks to the micro-vertexing capability of the emulsion technique, especially for short proton tracks, the stated experimental goal is to focus on verification of "2p2h interactions" on oxygen and an exclusive precise measurement of ν_e interactions with oxygen nuclei. Both of these measurements can in principle reduce the uncertainty due to neutrino-nuclear interactions used in the T2K oscillation analyses.

The conceptual design is an Emulsion Cloud Chamber interleaved with water-layers followed by a precision (SciFi) tracker with timing information, placed in front of an INGRID module to measure muon momentum. The committee heard various achievements in pilot experiments with 1-60 kg detector masses T60/T66/T68 and the current status of E71 preparation. The committee had a positive impression that any technical preparation, such as film refreshing, water-ECC construction, event matching with SFT/IGRID and demonstration of real analysis results, was successfully addressed.

At this meeting FIFC reported that they found no serious technical issues for E71 setup. The committee is glad to see the MOU with T2K and the successful grant application.

The group requests stage-2 approval to proceed with further preparation of detector. The committee, however, could not fully assess what the NINJA's primary deliverables are and how this will benefit the T2K analysis. For example, the signal being measured was not clear and its definition needs to be clarified.

NINJA's beam request was for neutrino mode only in order to detect short proton tracks in final states and due to the smaller contamination of wrong-sign neutrinos, because in anti-neutrino mode, the "2p2h process" is assumed to produce neutrons in the final state, which would not be visible in NINJA. On the other hand a measurement of electron neutrino charged current interactions with and without a proton in the final state might be of particular interest to get better constraint on the antineutrino to neutrino ratio for that flavor of neutrinos.

The committee notes that "verifying 2p2h interactions" is not a model-independent goal, and a more appropriate goal might be something more accurately described as a "measurement of the cross section for charged current zero pion events that have two protons identified in the final state". The committee suggests that NINJA consider what measurement can be made of that two-proton process that would be model independent, which can then be used as a check on the "2p2h models" that T2K is considering using in their oscillation analysis.

The committee recommends stage-2 approval if the NINJA collaboration is able to reasonably address the following concerns. Preliminary reply from the group should be provided by the end of October 2018.

1) Please describe the specific deliverable that you propose to measure, preferably one that can be defined in a model-independent way. Is the goal to measure a flux-integrated absolute measurement of the cross section for events with two protons in the final state above some proton momentum threshold? Is it a ratio of the 2-proton to 1-proton charged current zero pion events as a function of muon longitudinal momentum?

   Please describe the strategy to use the exclusive measurement including short tracks, and what are the systematic errors, for example two-proton event signal and backgrounds? Will this be a differential cross section, and if so, as a function of what kinematic variable?

2) Are there any measurements that are useful to T2K that could be made in the antineutrino mode of the beam? If so, then please state the specific (again, preferably model-independent) deliverable and what the statistical and systematic uncertainties might be on that deliverable.

E21 (COMET)

The E21 (COMET) experiment aims to observe charged lepton flavor violation through the μ to e transition in the muonic Al atom. The status report presented to PAC mostly concerns Phase I of the program, which uses a lower intensity beam and a simplified

apparatus. Phase I already offers the possibility to probe for new physics with a 100 fold improved sensitivity, assuming 150 days of data taking.

COMET, a large international collaboration (17 countries) of about 200 members, continues to expand, with three new institutions joining in 2018.

The 8 GeV test of the proton extinction ratio in between bunches took place after the previous PAC meeting. In this test the 8 GeV beam emittance turned out to be better than expected. After careful tuning of the extraction scheme of the four acceleration buckets in MR, an acceptable extinction ratio was achieved for the first three bunches, but not for the last bucket (K4 rear), as of today. They observed proton leakage in the bucket during the 1st 100 milliseconds, which should be clarified and removed in future accelerator study. The PAC looks forward to learning more in January 2019 about the status of this issue, but considers that a very important milestone has already been achieved.

COMET has set up an editorial board in order to release the TDR of Phase I by the end of the year, including a ~100-page summary meant for publication. In the meantime, the group is preparing the input to the European Strategy update (deadline 18th of December 2018), which implies revisiting Phase-II expectations.

On the detector side, prototypes, R&D and tests are proceeding well. At some point, the multiple tracking approaches should be unified. A presentation of the status of the experiment's preparations for Physics analysis would be welcome: organization, resource needs, reconstruction software, detector performances, and, more generally, analysis plans.

The PAC congratulates the COMET collaboration for its steady progresses and achievements.

E45 (Baryon PWA)

The E45 experiment aims to measure the $\pi N \rightarrow \pi\pi N$ and $\pi N \rightarrow KY$ reactions at center of mass energies in the range W=1.54 - 2.15 GeV in order to clarify the existence and properties of nucleon resonances up to 2 GeV through partial wave analysis (PWA). The experiment fully utilizes the newly-constructed 4π-detector, the Hyperon Spectrometer (the superconducting Helmholtz magnet and the time projection chamber, HypTPC), which will be used for the stage-2 approved experiment, E42 (H dibaryon search). The E45 experiment will be conducted at the K1.8 beam line with $\pi^{\pm}$ beams of $\sim 10^6$ per spill with a small momentum bite by changing the beam momentum from 0.74 to 1.98 GeV/c with 0.02 or 0.025 GeV/c steps.

In the PAC meeting, the group addressed the questions raised in the previous PAC report. As for the physics case in the proposed experiment, an example was given to show possible large effects of a new resonance on the total cross sections and the mass distributions in the $\pi\pi N$ channel. It was mentioned that the $\pi\pi N$ channel data will be analyzed via coupled-channel PWA by three different theory groups, which the PAC

found to be quite important to avoid possible ambiguities from different theoretical treatments and to ensure the reliability of the analysis. The PAC also found that the statistical quality of the data and the beam momentum steps seem to be reasonable. The group stressed that possible systematic errors in the proposed experiment can be suppressed by comparing the pion elastic scattering data with the existing high-quality world data. They also demonstrated that clear identification of hyperon production channels is possible via the kaon missing mass spectrum. The PAC recognized that most of the questions are reasonably answered.

Preparation of the apparatus and the detectors is going smoothly. The TDR has been updated on target installation, segmentation of the TPC hodoscope, etc., and reviewed again by FIFC with a satisfactory response. The group recently studied performance of the HypTPC with intense beams at HIMAC and found it working well at 1 MHz beam intensity as expected in the E45 experiment. A long-term test of the superconducting magnet as well as a test of the liquid hydrogen target is also in progress. The experiment will be ready to run in 2019.

The PAC understands the importance of collecting the $\pi\pi$N channel data and expects E45 to make significant contribution in the exploration of the nucleon resonance spectrum. The PAC also appreciates their steady progress of the preparation for the experiment. Therefore, the PAC recommends stage 2 approval to E45. Considering the heavy demands for MR beam time, the PAC requests that the group further examine ways to reduce the total beam time requested and to find an efficient running scheme, including quick but careful beam tuning.

E36 (Lepton Universality)

E36 (Lepton Universality) main goal is to measure the ratio of branching ratio Br($K^+ \rightarrow e^+ \nu$) over Br($K^+ \rightarrow \mu^+ \nu$). The collaboration aims to match the current measurement precision (but with different systematics), which shows agreement with the Standard Model prediction at 0.4% level. The deviations from the Standard Model recently observed in lepton universality violating B decays make this measurement highly relevant. In addition, the tests of lepton universality is complementary to searches for lepton flavor violation performed e.g. by COMET.

Preliminary results of the data analysis were presented in this status report. In particular the Kl2ee decays were observed which are a background process for the Dark Photon search in E36.

The PAC strongly encourages a timely completion of the analysis and expects a status report on the final analysis, and its corresponding publication plan, to be presented at the January 2019 meeting.

E03 (X-ray from Ξ^- Atom)

The E03 experiment aims at the world's first observation of X-rays from Ξ-atoms. From the energy shift and the width of the X-rays, information on the real and the imaginary parts of the Ξ-nucleus optical potential is obtained. It provides constraints on the Ξ-nucleon potential, which may be of importance in the discussion on the structure of heavy neutron stars. As a first step towards the future systematic studies, E03 will measure the X-rays from the Ξ-Fe atom. The Ξ particle will be produced via a (K^-, K^+) reaction on an iron target and will stop in the target, forming Ξ -Fe atoms. The transitions will be identified by the measurement of the X-rays by a Ge detector array.

Experiment E03 proposes a two-phase strategy. In the first phase, the experimental conditions will be optimized using about 10% of the beam time measuring the transition from the n=7 to the n=6 states, which is rather easy to observe, although it is not expected to show a significant shift and width due to the strong interaction between Ξ and Fe. In the second phase the transition from the n=6 state to the n=5 state will be observed.

The commissioning runs were performed in June 2017 and Feb. 2018 and the conditions of the gamma-ray measurements were carefully examined. The distance of the gamma-ray detector from the target has been optimized to be 6 cm in a compromise between the detection efficiency and the over-killing by Compton suppression. It was confirmed that a reasonable detection efficiency and signal to noise ratio are obtained with this condition as expected.

The proponents requested 15 days of beam time together with 3 days for the commissioning and calibration runs after the E40 experiment, with a switchover time of four months. The allocation of the beam time after completion of the E40 experiment should be considered in the next PAC.

E07 (Double Strangeness)

The hybrid-emulsion experiment E07 is a unique experiment aiming at the precision study of the ground state masses of light double-hypernuclei. This is of importance not only because of the intrinsic interest in these novel systems but because of the constraints such data will place on the role of hyperons in heavy neutron stars.

After the successful irradiation of the emulsion plates in 2017, the PAC is satisfied with the significant progress in the successful processing of the emulsion plates. The committee congratulates the collaboration on the detection of the first signals of doubly strange systems including 5 double Lambda events and 5 twin events. The PAC hopes that the manpower presently working on the analysis can be maintained in future. In order to guarantee the transfer of knowledge, a detailed documentation of the data and the analysis procedure seems mandatory and securing continuous support for human resources working on the analysis during the next years is recommended.

The PAC is very pleased to see that E07 is starting to explore the full scientific potential of the excellent data contained in the emulsions. The committee hopes that the interesting search for X-ray transitions in heavy Ξ^- atoms will only be the first step to broaden the physics program of E07. The list of possible topics may, e.g., include a search for decays of single hypernuclei, the elastic scattering of Ξ^- hyperons or the interactions of energetic Ξ^- hyperons with nuclei contained in the nuclear emulsions.

E16 (Spectral Change of Vector Mesons in Nuclei)

E16 is an experiment to measure the spectral function of vector mesons at finite density via the e^-e^+ invariant mass spectrum. The spectral function of hadrons at finite temperature and/or density is one of the fundamental and important observables in QCD matter physics.

The dilepton spectrum at high temperature displays a broad accumulation of low mass strength and other finite temperature effects. By comparison, the KEK E325 experiment showed the modification of the spectral function at finite density, which may be interpreted as a mass shift of ϕ meson. It is valuable to confirm/update this "mass shift", and the high momentum beam line should be ready at the beginning of 2020.

In the 2017 July PAC meeting, the PAC recommended Stage-2 approval for Run0 and encouraged the group to thoroughly review the strategy of beam commissioning in close cooperation with the beamline team. In the current PAC meeting, the E16 collaboration presented the updated strategy and the schedule toward Run0 expecting the beam time at the beginning of 2020. With the aid of newly approved grant-in-aid (KAKENHI Kiban S), the previous Run0 configuration (6(SSD)+6(GTR)+2(HBD)+2(LG)) is updated to a new configuration (6(SSD)+8(GTR)+4(HBD)+4(LG)). Three students joined the collaboration and are working on the detector, firmware and ASD. The PAC understood that the Run0 can be ready before the possible early 2020 beam time. With the approved 40 shifts x 8 hours (10 shifts of beam halo minimization and 30 shifts of detector commissioning (including background study and data taking)), the number of produced ω meson would be comparable to that in the KEK E325 experiment.

The PAC is concerned about the tight schedule of the preparation. Installation of experimental apparatus has to be finished before the high-p beam line becomes ready and the ceiling is closed. And the magnetic field mapping, where detailed scan is crucial to obtain good momentum resolution, is likely to be time consuming and should be carefully considered in their time schedule. The PAC recommends E16 to have close contact with the hadron hall staff members for the development of the detailed schedule.

The stage-2 approval for Run-1 will be discussed based on the results of Run-0. It is good news that in Run1, 6(SSD)+8(GTR)+6(HBD)+6(LG) configuration is secured by the grant. The long beam time request (160 shifts x 8 hours for Run1 and 320 shifts for Run2) is of concern.

E62 (TES)

The result of the E62 experiment performed in June 2018 was reported. The X-rays from kaonic ^{4}He and ^{3}He atoms emitted in the transition from the 3d to the 2p orbitals were successfully observed, which is relevant to resolve the long-standing problem on the depth of the K^- nucleus potential. Since the widths of the transitions are predicted to be as small as 2eV, a high energy-resolution measurement using superconducting transition-edge-sensors (TES) was introduced.

The PAC congratulates the successful observation of the X-rays using the TES detector for the first time in this field and is looking forward to the result of the analysis, which is now ongoing.

E57 (SDD)

E57 aims at a pioneering measurement of X-rays from K^--d atoms. A precision measurement of the shift and width of the 1*s* state by the strong interaction will provide unique information on the kaon-neutron interaction at threshold. Prior to stage-2 approval, the collaboration intends to validate their Monte Carlo estimates of backgrounds by a short test measurement with a liquid hydrogen target. For this pilot experiment with hydrogen, E57 asks for 3.0 days for beam tuning and detector commissioning, to be followed by a short 3.5 days data taking run.

The PAC is happy to see that the preparation for the pilot run of E57 is continuing smoothly. All 48 required Silicon Drift Detectors are available at J-PARC and will undergo final tests until the end of 2018. The installation of all other components of the experiment is on time and can be finished during the last quarter of 2018. The final tests of the complete setup will be performed early 2019.

The PAC acknowledges the readiness of E57 for the test run. Considering the fact that this relatively short measurement can provide already a very competitive measurement of the hadronic shift and width of kaonic hydrogen, the committee recommends the allocation of the requested beamtime (6.5 days) during the hadron hall running period envisaged for March/April 2019.

4. Summary of BEAM TIME ALLOCATION from October 2018 to June 2019

The PAC heard that operation period of MR for users in the latter half of FY2018 is one-month due to funding constraints. Full operation, in the new JFY, from April to June in 2019 is planned. In total, 4 months of operation is currently planned until next summer. The Super K tank repair work will continue until the end of CY2018 and T2K can take beam from January. The KOTO detector upgrade work will complete in February 2019 and they can take beam from March. No beam for HD can be delivered beginning May 2019 to allow enough time for cooling before the planned HD target replacement later in the year. Assuming this tentative accelerator operation schedule,

97.5 days of user operation is expected during the 4-months period from March to June in 2019.

The PAC recommends that the completion of the E40 experiment, with both Σ^+ and Σ^- physics data taken, as well as the E57 commissioning run take place before Summer 2019. It recommends an allocation of 47.5 days for these two experiments and the KOTO experiment. The remaining 50 days are recommended for allocation for the T2K experiment. Other stage-2 approved experiments in the near detector hall should run parasitically with T2K. Both allocations include the necessary accelerator tuning and studies to establish stable/improved user operation.

This schedule curtails the allocation requests of E40 and T2K due to the constrained beam availability. If additional operation becomes possible in JFY2018 with additional funding, restoration of the E40 full allocation request (additional 9 days) should be prioritized followed by additional running for T2K.

5. DATES FOR THE NEXT J-PARC PAC MEETING

The next J-PARC PAC meeting will be held January 16-18, 2019.

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

- Minutes of the 25th J-PARC PAC meeting held on 15-17 January, 2018 (KEK/J-PARC-PAC 2018-14)
- Proposals
  - P73 experiment: ${}^{3}_{\Lambda}H$ and ${}^{3}_{\Lambda}H$ Mesonic Weak Decay Lifetime Measurement with ${}^{3,4}He(K^-,\pi^0){}^{3,4}_{\Lambda}H$ Reaction (KEK/J-PARC-PAC 2018-24)
- Technical Design Reports
  - Update of Technical Design Report (TDR): Searching for a Sterile Neutrino at J-PARC MLF (E56, JSNS2) (KEK/J-PARC-PAC 2018-15)
  - Technical Design Report (TDR): Study of neutrino-nucleus interaction at around 1GeV using cuboid lattice neutrino detector, WAGASCI, muon range detectors and magnetized spectrometer, Baby-MIND, at J-PARC neutrino monitor hall (E69, WAGASCI/Baby-MIND) (KEK/J-PARC-PAC 2018-17)
  - Technical Design Report on the Experiment E45 (KEK/J-PARC-PAC 2018-18)

- J-PARC E71 Technical Design Report (KEK/J-PARC-PAC 2018-19)

➢ Reports

- E56 response to the minutes of the 25th PAC (KEK/J-PARC-PAC 2018-16)
- Summary of Reports of the Technical Design Focused Review Committee of the Updated J-PARC E34 g-2 Experiment Technical Design Report (KEK/J-PARC-PAC 2018-20)
- E65 (T2K-II) Status report: J-PARC Neutrino Beamline Upgrade Technical Design Report (submitted to the dedicated review committee) (KEK/J-PARC-PAC 2018-25)
- Report from J-PARC Neutrino Beam Line Upgrade Technical Advisory Committee Meeting (KEK/J-PARC-PAC 2018-26)

➢ Letter of Intent

- Decay Pion Spectroscopy of ${}^{5}_{\Lambda\Lambda}H$ produced by ${}^{7}Li$ (K^-, K^+) reactions (KEK/J-PARC-PAC 2018-23)

➢ MOU's

- Memorandum of Understanding (MoU) between T2K collaboration and the NINJA collaboration (KEK/J-PARC-PAC 2018-21)
- Integration of WAGASCI (E69) experiment into the T2K experiment (KEK/J-PARC-PAC 2018-22)