

KEK/J-PARC-PAC 2007-1

12 January 2007

J-PARC Program Advisory Committee
for the
Nuclear and Particle Physics Experiments at the J-PARC 50 GeV Proton
Synchrotron

Minutes of the second meeting held on
10-12 January 2007

OPEN SESSION (10-January-2007):

1. Status of J-PARC Project: S. Nagamiya
2. Status of J-PARC Accelerator: H. Kobayashi
3. nu-TAC Report: E. Blackmore
4. JNRC Report: H. Iwasaki

OPEN SESSION (11-January-2007):

1. P03: Pion double charge exchange on oxygen at J-PARC: A. Krutenkova
2. P10-1: Production on Neutron-Rich Lambda-Hypernuclei with the Double Charge-Exchange Reaction : A. Sakaguchi
3. P10-2: Exclusive Study on the Lambda-N Weak Interaction in A=4 Lambda-Hypernuclei : S. Ajimura
4. P16: Electron pair spectrometer at the J-PARC 50-GeV PS to explore the chiral symmetry in QCD : S. Yokkaichi
5. P18: Coincidence Measurement of the Weak Decay of ${}_{\Lambda}^{12}\text{C}$ and the three-body weak interaction process : H. Bhang
6. E11 : Proposal for $K_L \rightarrow \pi^0 \nu \bar{\nu}$ Experiment at J-PARC : T. Yamanaka

7. E15: A Search for deeply-bound kaonic nuclear states by in-flight ${}^3\text{He}(K^-, n)$ reaction : M. Iwasaki
8. P21(LoI): An Experimental Search for $\mu^- e^-$ Conversion at a Sensitivity of 10^{-16} with a Slow-Extracted Bunched Beam: Y. Kuno
9. FIFC Report: J. Haba

CLOSED SESSION:

Present: T. Bressani, A. Ceccucci, H. En'yo, K. Hagiwara, E. Hiyama,
Y.B. Hsiung, K. Inoue, J. Imazato (Secretary), T. Ishii, T. Kishimoto,
T. Nakano, K. Nishikawa (Secretary), J-C. Peng, M. Shaevitz,
F. Takasaki (IPNS director)*, K. Tokushuku (Chairman),

*) Part of the time

1. PROCEDURE

The minutes of the first JPARC-PAC meeting (KEK/J-PARC-PAC 2006-1) were approved.

2. DISCUSSION ON J-PARC GENERAL STATUS

The PAC heard the status of the J-PARC from Prof. Shoji Nagamiya; the director of J-PARC center and from Prof. Hitoshi Kobayashi; the head of the KEK accelerator division I.

- Construction of equipment and facilities for J-PARC is almost on schedule. The budget of JFY2007 was now finalized by the finance ministry and will be submitted to the Diet.
- The J-PARC center has been formed and the organization structure during the operation period has been defined.
- A large review of J-PARC was started in early December. The committee members have been appointed by the government. The committee will review many topics, including the priority of the phase 2 projects, the organization structure, operation

budget, PAC, internationalization, research buildings and lodging facilities. Their report is scheduled to be produced to meet the budget deadline for JFY2008.

- Since the beginning of October, the commissioning of linac has started and the area has been closed due to radiation safety. The first beam injection through the RFQ was successfully performed on November 20. The beam was successfully accelerated to 50 MeV with the DTLs on December 20.
- There were significant problems in the production of the ceramic beam pipe in 2005. Most of the problems have now been solved. Long term tests of finemet used in the RF cavities have been ongoing. A 1000 hour test run has gone well for both RCS and MR cavities.
- Tests of injection and extraction components are progressing. Some problems have been found and are being solved as they are discovered.

Hearing these reports, **the PAC congratulates the J-PARC team for the enormous progresses in the construction of J-PARC and timely start of the beam commissioning in the Linac.** The PAC also appreciated the arrangement of the J-PARC tour on January 8th which gave the PAC first hand knowledge of the clear progress on every part of the complex.

3. Report from the Facility Impact and Funding Committee (FIFC)

The PAC heard presentations and received reports from the FIFC. The reports covered the stage-2 approved experiments (E05 and E13) and the stage-1 approved experiments (E07, E15, E17 and E19). In addition, the FIFC evaluated the K1.8 and K1.8BR beamlines and the SKS spectrometer. The FIFC found that there were no concerns with the E05 and E13 experiments. The issues on the other experiments will be described in the following sections. The general issues are listed in order.

1) K1.8 and K1.8BR beamlines

The FIFC reported that there was no problem in the prospect that the beamlines will be operational with sufficient performance for the experiments. The high K/π ratio was confirmed independently by the external reviewer; Dr. J. Doornbos of TRIUMF. The estimate of the K/π ratio, however, has a large uncertainty so that the experimental groups should be conservative for the

planning of the rate capability of beam detectors and the DAQ performance. It was also pointed out that halo muon rate may be high in the K1.8 BR beamline.

2) SKS Spectrometer

The FIFC has found no unforeseen problems with using the SKS spectrometer owing the experience using it at KEK-PS since 1992. The new cryogenic system will become simpler and more portable. Since many experiments use the spectrometer, it should be designed, constructed, and operated as a common facility.

3) Beamline detectors

Beamline gas chambers for E05, E13 and E19 are required to work under high-intensity beams. The FIFC encourages forming a collaboration among the experimental groups to develop the detector system including its electronics and DAQ.

4) Human Resources

In the E05, E13, E19 and E07 collaborations, many physicists have signed up for more than one proposal. The FIFC feels that the actual commitment of each participant should be made clear. The planned commitments in term of person-year of each participant should be reported to the PAC

5) Experimental Program Coordination

For the efficient use of the beam and to enhance the prospects of good physics results in the early periods, good experimental program coordination will be required. Early formation of a coordination team would be very helpful to arrange the floor usage, space allocation for experiment preparation and beam time allocation.

The PAC appreciated the thorough review made by the FIFC on a very short time scale. The review provided key input to the PAC in its deliberations and the FIFC comments were most useful in considering the experiments. The PAC strongly endorses the proposal to form an experimental program coordination group. The PAC would like to hear a report from this group regularly at every PAC meeting once J-PARC is operational.

4. PROPOSAL EVALUATION

1. P08: Study Pion double charge exchange on oxygen at J-PARC

The main goal of the proposed experiment is to investigate the reaction mechanism of pion double charge exchange (DCX) reaction at high energy. Existing data from meson factories at low energies can be well described by the sequential single charge exchange (SSCX) process. However, recent inclusive DCX data collected at ITEP and KEK at higher beam energies ($0.5 < T < 1.1$ GeV) show significantly larger cross sections than predicted from the SSCX, suggesting the presence of new reaction mechanism at these energies. In particular, calculations based on the inelastic scattering (IR) mechanism, first formulated by Gribov, appear to describe the data satisfactorily. The proposed experiment aims at extending the measurements to even higher energies ($1 < T < 2$ GeV) using the pions from the K1.8 beamline and the SKS spectrometer for detecting the inclusive $^{16}\text{O}(\pi^+, \pi^-)X$ and the exclusive $^{18}\text{O}(\pi^+, \pi^-)^{18}\text{Ne}$ reactions.

While the stated goal of this proposal is of some interest, the PAC recognizes that the proposed study could also shed some light on the reaction mechanisms of the strangeness-exchange DCX reactions such as the (π^-, K^+) and (K^-, π^+) which could produce neutron-rich Λ -hypernuclei. **Due to the important connection of the proposed measurement to the (π^-, K^+) and (K^-, π^+) reactions, the PAC recommends stage-1 approval.** While the proposed measurements could be readily performed after the beamline and SKS become available, the priority of this experiment is judged to be lower than the other hyper nuclear experiments currently approved for the K1.8 beamline.

2. P10: Study on Λ -Hypernuclei with the Charge-Exchange Reactions

The authors have fully accepted the comments of the PAC, by splitting the original proposal P10 into two separate ones. The PAC has decided that the new proposal titled “Production on Neutron-Rich Lambda-Hypernuclei with the Double Charge-Exchange Reaction” will be referred to as P10 and the proposal titled “Exclusive Study on the Lambda-N Weak Interaction in A=4 Lambda-Hypernuclei” will be referred to as P22. The spokespersons of the P10 proposal are A. Sakaguchi (Osaka U) and T. Fukuda (Osaka EC U). Those of the P22 proposal are S. Ajimura (Osaka U) and A. Sakaguchi (Osaka U)

The new proposal P10 is aimed at the study of the production of neutron-rich Λ -hypernuclei with the double charge-exchange reaction.

The study of such systems is very challenging since, thanks to the Glue-like role of the Λ hyperon, stable nuclear systems with an N/Z ratio very much larger than the ordinary nuclei, can be produced and studied.

The targets that will be used are ${}^9\text{Be}$ and ${}^6\text{Li}$, leading respectively to the systems ${}^9_{\Lambda}\text{He}$ and ${}^6_{\Lambda}\text{H}$.

Production of the first was already observed by the proponents but the poor statistics did not allow for the identification of discrete final states, whereas the observation of the second one would be very important in order to verify the validity of recent theoretical approaches.

The experimental method and equipment for these measurements is well understood from the previous experiment at the KEK PS.

The PAC recommends the stage-1 approval for the P10 proposal.

The aim of P22 is an Exclusive Study of the ΛN weak interaction in $A=4$ Λ hypernuclei.

The non mesonic weak decay (NMWD) of Λ hypernuclei is a unique window for the study of the strangeness changing weak interactions among 4 baryons. Since it occurs not in vacuum, but in the presence of other nucleons, it must be “cleaned up” by other effects like final state interactions and/or mechanisms involving more nucleons. The $A=4$ system is the simplest for which NMWD were observed, with large errors.

The simplicity of this nuclear system allows also for testing the validity of the $\Delta T = 1/2$ rule even for NMWD. The proposed experiment aims at a precise measurement, with an improved apparatus which should allow for careful control of possible systematic errors.

The PAC recommends stage-1 approval for the P22 proposal.

3. **P18:** Coincidence Measurement of the Weak Decay of ${}^{12}_{\Lambda}\text{C}$ and the three-body weak interaction process

The authors presented an updated report, following the recommendations of the PAC.

The aim of the experiment is a study of the non mesonic weak decay of ${}_{\Lambda}^{12}\text{C}$, studied previously at the KEK PS with smaller statistics.

In a complex nucleus like ${}^{12}\text{C}$ the importance of the three-body weak process $\Lambda\text{NN-NNN}$ is predicted by some theoreticians to be as large as 20% of the $\Lambda\text{N-NN}$ weak process, an important contribution that must be known for a good description of the phenomenon.

The detector now presented is considerably improved, in particular with regard to the measurement of the proton energy.

A method for disentangling the final state interactions that may bias the interpretation of the data is presented and discussed. It is based on the back-to-back and non back-to-back angular correlations, on the energy distributions of the nucleons and finally by the comparison of the neutron-proton and proton-proton pairs. This last one, the proton-proton, is produced only as an effect of the final state interactions.

In conclusion the PAC recommends the proposal for stage-1 approval.

4. **P16: Electron pair spectrometer at the J-PARC 50-GeV PS to explore the chiral symmetry in QCD**

The goal of this proposal is to search for experimental evidence for the onset of chiral symmetry restoration in nuclear matter. In the previous meeting, the PAC considered that the physics addressed by this proposal is important and worth pursuing at J-PARC. However, the PAC expressed a concern that the toy-model used by the experimenters may be insufficient to extract evidence for chiral symmetry restoration in p-A interaction.

After hearing the presentation this time, the PAC considers that it is still not clear if the restoration of the chiral symmetry will be a unique explanation of the data. The PAC, however, does appreciate as before the importance of confirming (or not) the previous experimental results (KEK PS-E325). In particular, detailed measurements of the velocity and multiplicity dependence will further clarify the physics.

Therefore, the PAC recommends stage-1 approval.

5. E07: Systematic Study of Double Strangeness System with an Emulsion-counter Hybrid Method

The PAC received a report from the FIFC committee on the evaluation of the experiment. There is no major technical problem in the experiment. The FIFC judges that the installation of Kurama magnet is both possible and preferable for acquiring more statistics. The FIFC considers that good alignment between the two DSSD detectors and the emulsion stack is important for an efficient scanning. The strategy of the alignment procedure is, however, not well documented and reviewed.

The PAC recommends stage-2 approval for E07. The PAC takes note of the issues associated with alignment and would like to hear the strategy of the E07 group at a future meeting.

6. E15: A Search for deeply-bound kaonic nuclear states by in-flight $^3\text{He}(K^-, n)$ reaction

The experiment E15 intends to search for deeply bound kaonic states with a helium-3 target. This experiment is motivated by the proponent's previous experiments with helium-4 targets at the KEK-PS (E471). The group reported the preliminary results of E471. The PAC was disappointed that the famous tribaryon peak (K^*ppn) discovered in the previous experiment was due to an experimental artifact. The PAC thus revisited the merit of the proposed experiment, and concluded that the physics case to search for deeply bound kaonic states is still strong since the FINUDA experiment has reported a K^*pp bound system. The PAC also concluded that the proposed E15 experimental method, having the over-constraint of both missing mass and invariant mass measurements in the in-flight kaon reaction $K^-(^3\text{He}, K^*pp)n$, should be able to give a conclusive answer on the existence of the bound K^*pp system.

The PAC received a report from the FIFC, which indicated no major concerns on the experimental feasibility.

Therefore, the PAC recommends stage-2 approval for E15. This experiment should be done as a Day-1 experiment, but not with top priority.

7. E17: Precision spectroscopy of Kaonic $3\text{He } 3d \rightarrow 2p$ X-rays

The PAC received a report from the FIFC committee on the evaluation of the E17 experiment. There were no concerns with the experiment. The FIFC however noticed that the E17 requires small systematic errors similar to the statistical one which are at the 2 eV level. Reaching this level might be an issue even with the planned in-situ calibration by Ti/Ni $K\alpha/\beta$ Lines. Detailed evaluation of the systematic errors associated with the experiment and the status of the previous KEK-PS experiment (E570) should be reported.

The PAC recommends stage-2 approval for E17. The PAC would like to receive a report on the systematic error evaluation at a future meeting.

8. E19: High-resolution Search for Θ^+ Pentaquark in $\pi^-p \rightarrow K^+X$ Reactions

The PAC received a report from the FIFC committee on the evaluation of the E19 experiment. There were no major concerns for the experiment. The FIFC noticed that a significant sensitivity would be achievable with rather low statistics and, thus, with low beam intensity. Optimization of statistics should be performed and the sensitivity goal should be presented to the PAC.

The PAC recommends stage-2 approval for E19. The PAC also takes note of the FIFC comments.

9. E11: Tokai-to-Kamioka (T2K) Long Baseline Neutrino Oscillation Experimental Proposal

The T2K experiment is making rapid progress towards beginning data taking in 2009. There has been successful production of the first superconducting combined function magnet for the beam line and 320 kA test operation of the first horn has been continuing over the past five months. The T2K collaboration has submitted a detailed Technical Design Report (TDR) for the ND280 near detector which defines the technologies, capabilities, and plans for all the detector systems.

The PAC heard presentations and received reports from two external committees: 1) the Neutrino-Technical Advisory Committee (nu-TAC) which met in Nov., 2003 and Apr., 2005, and Sept., 2006 and 2) J-PARC Neutrino Experiment Review Committee (JNRC) which met in Nov. 2006. In addition, the PAC received, from

the T2K collaboration, an answer report addressing the questions from the June 2006 PAC meeting.

The conclusion of the nu-TAC committee was that the goal of neutrino beams in April 2009 is still okay. The committee felt that no fundamental design concerns remain for the neutrino beamline, target, horn, and dump although there are many details that remain to be worked out and implemented. Specific comments by the nu-TAC committee include:

- 1) FY2007 and FY2008 are critical years for the remaining prototyping, production, and installation.
- 2) The schedule for the Target Hall is critical as many components have to come together in sequence for this to be successful.
- 3) It is extremely important that components in high radiation areas are well commissioned prior to receiving large radiation activations.

The JNRC committee was set up by the IPNS Director to be a standing review committee on the technical aspects of the T2K experiment including the feasibility of the detector and beam technologies as well as the schedule, budget profile, organization, manpower, and infrastructure needs of the experiment. After receiving the ND280 TDR, the committee held a two day review on Nov. 28-29, 2006 of the technical details, schedule, and budget for the T2K ND280 near detector. Overall, the committee considered that, at the current stage of simulation, the ND280 system could fulfill the physics requirements of the T2K experiment. Specific comments by the JNRC in their report to the Director include:

- 1) Both the multi-pixel Geiger mode avalanche photodiodes (APD) as photo sensors and the Micromegas technology for the TPC gas amplification device are mature and feasible technologies for the ND280 detector.
- 2) Simulation studies of the ND280 performance as a “whole detector system” should be improved.
- 3) Long term stability and lifetime tests of the APD photo sensors should be made since these components are new types of devices. The acceptable failure rate in the detector should be studied with simulation.

- 4) The TPC plays a key role in momentum measurements and particle identification. In order to get good dE/dx resolution, the gain uniformity is essential. Therefore, it is mandatory to establish an adequate in-situ gain calibration method.
- 5) The construction organization and responsibility are well defined for the ND280 systems and the collaboration should move to include quality assurance, installation, integration, commissioning, maintenance, and operation as part of these obligatory responsibilities.
- 6) The progress of the construction should be regularly monitored.
- 7) The ND280 detector building will not be available until Jan. 2009 and the installation of the INGRID, FGD, and TPC will have to be completed within three months. Such a fast installation and commissioning will require careful preparation and organization. Also, to make this happen will require reasonable working and storage areas near the ND280 building so that component testing and quality assurance can continuously proceed.
- 8) The committee did not examine the correctness of the budget but said that the responsibilities were well defined and assumed that each institute had requested the necessary budgets from their funding agencies.

The PAC concurs with the comments and suggestions made by the nu-TAC and JNRC committees. The PAC also received from the T2K collaboration answers to the questions posed at the 1st PAC meeting in June, 2006. As a whole, most questions were thoroughly addressed and detailed discussions concerning many of the issues were given in the ND280 TDR. As stated by the JNRC, in several areas the simulation work needs to be improved with the goal of modeling the detector as a whole. With this full simulation, the T2K group will be able to study and define the physics capabilities of the detector. As the detector components and simulations become more defined, the PAC would like to see estimates for the systematic uncertainties associated with the cross section and flux measurements of the total system with respect to defining the expected events in the SuperK detector.

For the next meeting, the PAC requests a status report from the T2K collaboration which should also cover:

- Results from improved simulations of the ND280 detectors and methods to extract the water cross sections and fluxes.
- The PAC would like to see an analysis of the full systematics associated with the disappearance and appearance oscillation analysis. The near detector measures the flux times cross section to be applied to events in the SuperK detector. Besides the systematics associated with these measurements and the extrapolation to the far SuperK detector, the analysis should also include systematic uncertainties associated with the SuperK detector efficiency, energy resolution and event classification.
- An updated construction schedule for the beam, horn, and ND280 detector along with progress on prototype testing and actual component and module production.
- The installation schedule has been flagged as an area of concern. An update on the planning and resources for pre-commissioning and installation should be given.
- An update on the budget estimate and the securing of funding should be given.

10. E14: Proposal for $K_L \rightarrow \pi^0 \nu \bar{\nu}$ Experiment at J-PARC

The committee heard a report from the E14 Collaboration. The analysis of the E391a data set is progressing. There is good agreement between the simulation and the data for halo- neutron induced backgrounds in the side-bands. Optimizations of the signal region are still being carried out. Concerning the E14 beam-line design, the study of the collimators is continuing. A detailed simulation will be performed once the choice for the collimator layout will be made. It was pointed out that a complete K0 layout is required to enable FIFC to evaluate the E14 impact on the J-PARC facility. According to communications between E14 and the Fermilab Director, an agreement for the use of the KTeV crystals in E14 seems feasible. The possibility to equip the 2800 KTeV PMT's with amplifiers in order to avoid the purchase of new tubes is under study.

Answers to PAC questions related to the status report submitted by E14 at this meeting are included in the Appendix of the latest version of the document. The review of the E14 technique and in particular the R&D progress and the strategy for background measurements will continue to be closely monitored by the PAC. In conclusion, the PAC was satisfied with the general progress and encourages the

collaboration to complete the data analysis of the pilot run and to address the remaining R&D issues.

11. **P21(LOI): An Experimental Search for μ^-e^- Conversion at a Sensitivity of 10^{-16} with a Slow-Extracted Bunched Beam**

The Collaboration aims to search for a μ^-e^- conversion at sensitivity of 10^{-16} . Observation of this lepton flavor violation process is a clear signal of physics beyond the Standard Model. In particular, some models with supersymmetric unification predict the conversion rate at $\sim 10^{-15}$. The μ^-e^- conversion has the potential to open a window for a new paradigm in particle physics in a complementary way to LHC and ILC. After the termination of the MECO project at the BNL-AGS, J-PARC is a unique place in the world to do such an experiment.

The PAC heard that the group is aiming to submit a proposal for the next PAC meeting. The PAC strongly encourages the collaboration make this submission. On the other hand, the PAC also notices that there will be potential interference between this and the other experiments in the hadron experimental facility. Since the 50GeV machine needs to be operated in a special mode for this experiment, the effect to the neutrino experiments also needs to be carefully studied. The PAC therefore urges KEK and the collaboration to have a close communication to solve the remaining key issues such as the beamline layouts and a high quality pulsed beam generation in slow extraction.

4. DAY-1 Experiments

After the discussions on the experimental proposals, the PAC reviewed the DAY-1 experiments and concluded that the priority assignments from the previous meeting are still reasonable. The PAC recommends the following experiments as the day-1 experiments: E11 on the neutrino beam line, E05, E13 and E19 on the K1.8 beam line and E15 and E17 on the branch of the K1.8 beam line. Among the experiments in the hadron experimental facility, the committee considers that E05 is the experiment with the first priority since the experiment is unique at J-PARC and explores the new area of nuclear structure with strangeness -2, with the high resolution SKS spectrometer. E13, which studies the hyper-nuclear structure with the lambda hyperon has second priority.

5. DATES FOR J-PARC PAC MEETINGS

Date for the next meeting is 6-7 July 2007. The tentative agenda is;

- Expected financial status of J-PARC and plans for JFY2007
- Report from T2K on near/far detector systematics

The 4th meeting date is tentatively set to 7-9 January 2007.

6. The J-PARC PAC received the following documents:

- Draft Minutes of the first J-PARC PAC meeting held on 30-June, 1-2, July 2007
- E14 Report to the 2nd J-PARC PAC meeting. Version 4.0
- Revised P10 Proposal-1 “Production on Neutron-Rich Lambda-Hypernuclei with the Double Charge-Exchange Reaction”
- Revised P10 Proposal-2 “Exclusive Study on the Lambda-N Weak Interaction in A=4 Lambda-Hypernuclei”
- Three Status reports from the P18 proponents.
- LoI (P21) “An Experimental Search for $\mu^- e^-$ Conversion at a Sensitivity of 10^{-16} with a Slow-Extracted Bunched Beam”
- Technical Design Report for T2K-ND280
- Facility Impact and Funding Committee (FIFC) Report
- Technical Review Report on the ND280 from J-PARC neutrino experiment review committee
- Answers from T2K group on the questionnaires from J-PARC PAC
- Document for ND280 Review: Organization and Budget Status*

*) restricted circulation