Draft (version 5/Nov/2008)
KEK/J-PARC-PAC 2008-11
17 October 2008

J-PARC Program Advisory Committee

for the

Nuclear and Particle Physics Experiments at the J-PARC 50 GeV Proton Synchrotron

Minutes of the 6th meeting held on
Thursday and Friday, 16-17 October 2008

CLOSED SESSION (16-October-2008):

1. Welcome: F. Takasaki (KEK)

OPEN SESSION (16-October-2008):

2. J-PARC Status: S. Nagamiya (J-PARC)

3. MR Status and Commissioning Plan: A. Ando (KEK)

4. Hadron facilities and test beamline: K. Tanaka (KEK)

5. FIFC Report on KOTO, SKS: J. Haba (KEK)

6. Report form Muon Task Force: S. Mihara (KEK)

7. P21 Report (An experimental Search for Lepton Flavour Violating mu-e conversion): Y. Kuno (Osaka)

8. E14 Report : T. Yamanaka (Osaka)

9. E06 Report : J. Imazato （KEK）

OPEN SESSION (17-October-2008):

10. P23 Report (Analyzing power A_n and A_{nn} in 30-50GeV very-high-pt2 pp elastic scattering) : A.D. Krisch (Michigan)

11. E11 Report : Neutrino Beam Line and facility: T. Nakadaira (KEK)

12. E11 Report : Near Detector Status D. Wark (IC London)

CLOSED SESSION(16,17-October-2007):

Present: A.Ando(J-PARC), A.Ceccucci, H.En'yo*, K.Hagiwara, J.Imazato (Secretary), H.Kobahyashi(J-PARC), T.Kobayashi (Secretary), S.Kumano, T.Mori, Y.Nagai, S.Nagamiya (J-PARC Center Director)*, S.N.Nakamura, T.Nakano, K.Nishikawa (Secretary), J.C.Peng*, N.Saito (Secretary), M.Shaevitz, S.Shimoura, F. Takasaki (IPNS director)*, R.Tschirhart, K.Tokushuku (Chairperson), H.Yamamoto*.

*) Part of the time

1. PROCEDURE

The minutes of the fifth J-PARC-PAC meeting (KEK/J-PARC-PAC 2008-5) were approved without correction.

2. DISCUSSION ON the J-PARC GENERAL STATUS

The J-PARC project leader S. Nagamiya presented the progress since the previous PAC meeting. A. Ando reported the status of the main ring (MR) accelerator.

Construction of the facilities is on schedule. Commissioning of the Rapid Cycling Synchrotron (RCS) with beam has proceeded and is in an advanced stage. 3 GeV beams were extracted to the neutron target in May. In June, the Bragg diffraction peak on a silicon crystal was measured with a world-record resolution (0.03%), thus demonstrating the excellent quality of the neutron beam from the new moderator surrounded by the innovative AIC alloy (Ag, In, Cd) jacket. In September, the muon facility started operation and the extracted power at the RCS reached 210 kW.

The PAC is impressed with all this progress and congratulates the J-PARC Center for the first results from the neutron and muon lines.

For JFY2009, a budget request was submitted to run the facilities for 7 cycles (154 days). The operational budget needs to increase in the future and the possible mechanism to ease the funding situation is under discussion with the funding agency. The Linac upgrade proposal to recover the injection energy to the RCS was submitted as a three-year plan to the agencies and additional funding was requested for 2 neutron beamlines along with instrumentation and research and lodging buildings.

The beam commissioning of the main ring (MR) was performed in May and June. During that time, injection, capture with the RF, and extraction of the beams were successfully tested. In December, acceleration to 30GeV and slow extraction will be started.

One problem was discovered during the May-June MR commissioning period, which was associated with ripple on the magnet power supplies causing tune shifts that gave poor beam survival. Rewiring and the application of extra filtering have reduced these effects significantly to the level such that 100 kW running for the fast extraction is achievable. Further investigation is ongoing with respect to the slow extraction. Other improvement will be necessary in order to reach the proposed intensity milestones above 100 kW in the future.

The PAC appreciates the significant work being done for curing the ripple problem associated with the magnet power supplies. The PAC considers that high power operation is essential for J-PARC and that future improvements to reach high intensity is crucial for carrying out the physics programs.

3. STATUS OF THE PARTICLE AND NUCLEAR PHYSICS FACILITIES AND A PLAN FOR TEST BEAM LINES.

K. Tanaka presented the status of the hadron area beam lines. Construction is on schedule. The primary proton beam line, T1 target, beam dump and K1.8BR beam line will be ready by the end of 2008, which will allow the slow beam extraction in January at a power of 1.2kW. The electrostatic beam separator for the K1.8BR beam line has been commissioned and is waiting for the installation. The K1.8 and K0 lines will be ready by September 2009.

A “test beam” line for detector tests was originally planned to be built at the T0 target area but was not included in the phase 1 planning. As an alternate plan for a test beam, there is a target monitor hole at T1 viewing the target at 50 degrees. A test beam line can be built downstream of this hole. The yield of charged pions with momentum of 0.5~1.5GeV/c should be reasonable with this arrangement. The cost for the beam line magnets is estimated to be ~50Myen, which needs to be secured. As the flux of the neutral particles is expected to be comparable to the charged particles, a shielding scheme will need to be worked out to make sure that the experiments in the K1.8BR area do not suffer from increased neutron background.

4. FIFC REPORTS

The FIFC chairperson, Junji Haba, reported on the recent review of the SKS spectrometer and KL beam line. The review took place on the 3rd of October. (The report on the KL beam line is discussed later in the E14 section.)

In the presentation of the SKS review, it was reported that a ground fault was found in the SKS coil during its stand-alone test. Isolating the section of the coil with the ground-fault will permit operation at 90% of the normal operational field, which is still acceptable for the approved experiments. A detailed 3D magnetic field calculation can provide a reliable field map of the reduced field. The validity of the calculated field was checked by comparing a calculation for the previous operational field against the previously measured map. On the other hand, this earth fault was unexpected, and the vulnerability of further faults represents a risk to the successful execution of the approved SKS experiments. The PAC is concerned that another possible ground fault would reduce the field to an unacceptable level.

5. PROPOSAL EVALUATION

1. **P23: (**Analyzing power A_n and A_{nn} in 30-50GeV very-high-pt2 pp elastic scattering)

   The PAC heard a presentation from P23 that addressed several issues raised by the PAC on this proposal. The primary issue is whether the proposed measurements could provide new insight into the long-standing puzzle of large A_n and A_{nn} in proton-proton elastic scattering. The PAC concluded that no compelling justifications were presented to warrant the considerable amount of effort and resources required to perform the proposed measurement at J-PARC. The main challenge for understanding the origin of the large A_n and A_{nn} appears to be theoretical, since the validity of the existing data is well established. The extension of the existing data to somewhat larger p_T^2 is unlikely to shed new light on this puzzle. The PAC recommends that the P23 proposal be rejected.

   The PAC agrees that understanding the large spin effects in proton-proton scattering is of significant importance and strongly encourages efforts to identify new measurements that could lead to a better understanding. These new measurements could possibly involve other experimental observables in

proton-proton scattering or scattering in other hadronic systems. Such new data are likely to bring new breakthroughs in theoretical understanding of this long-standing puzzle in hadron physics.

2. **P21:** An experimental Search for Lepton Flavour Violating mu-e conversion (The COMET experiment)

This proposal aims to improve the experimental sensitivity to detecting muon-to-electron conversion by 4 orders of magnitude over the current value. Measurements at this sensitivity level would probe the region of branching fractions expected by many well-studied new physics models such as SUSY-GUT. As such, it could become one of the flag-ship experiments at J-PARC. In addition, the muon source could be common with a future PRISM-type experiment, which would improve on the COMET sensitivity by an additional two orders of magnitude using a muon storage ring.

At this meeting, the PAC heard a report from the P21 proponents and the newly formed Muon Task Force (MTF). The Muon Task Force (MTF) group consists of accelerator and beam channel experts and members of the COMET collaboration. The MTF is a vehicle for the laboratory management to work closely with the COMET collaboration to develop a realistic overall design, set of milestones, schedule, and funding plan, including where and how to locate the experiment. In particular at this stage, the MTF efforts should be focused on a realistic design of the muon source and the related accelerator and beam line issues which are naturally a joint responsibility of the collaboration and laboratory. The PAC recommends that the MTF be further strengthened by additional members of the COMET collaboration.

The MTF and COMET proponents discussed plans for the conceptual design report and the R&D effort that will be needed for the experiment. The PAC response to these plans is summarized below.

Conceptual Design Report:

The COMET collaboration is developing a conceptual design report to deliver to the laboratory in the spring of 2009. The conceptual design report should present and describe the physics reach, experimental techniques, R&D plan, location, cost and schedule of the COMET experiment. Input from the laboratory on the funding profile, location, and schedule should also be included if possible. The PAC will

jointly consider the conceptual design report with the accelerator and facility requirements document from the MTF at a time determined by the laboratory. This will start the evaluation process prior to a stage-1 approval.

R&D Milestones:

The collaboration has developed a list of R&D critical to the conceptual design report, and should work further to develop a list of milestones with expected completion dates.

Beam extinction R&D:

The COMET experiment requires a RF train of proton pulses on the production target with an extraordinary level of beam extinction ($< 10^{-9}$) between pulses in the train. Previous measurements of beam extinction in special runs of the BNL AGS suggest that a level of at least 10^{-6} can be achieved through a straightforward modification of existing RF system in the RCS and MR accelerators in the J-PARC complex. The MTF and collaboration have proposed to measure the degree of extinction possible with the existing complex (KEK/J-PARC-PAC 2008-6). The PAC encourages the MTF and collaboration to pursue these measurements in a staged manner. The first step would be to demonstrate that backgrounds to the proposed technique to measure the extinction are under control at the required level and that the measurement technique has the required sensitivity.

It is likely that an external extinction system will be necessary to work in conjunction with an internal accelerator based extinction system in order to reach the 10^{-9} level. The COMET collaboration has formed a joint R&D project with the Fermilab “mu2e” collaboration to develop an external “AC Dipole” scheme to improve the extinction. The PAC encourages the laboratory to support this joint R&D project.

Solenoid R&D:

The PAC was impressed with the good progress demonstrated in solenoid R&D. The experiment requires three high performance superconducting solenoid systems, which potentially can be the cost and schedule driver of the experiment. The collaboration is working closely with the laboratory and industry to develop prototypes, the first of which for the transport solenoid system will be available for testing in the spring of 2009. The PAC strongly encourages the laboratory to continue support of this R&D, and to work with the collaboration in the early development of industrial partners for these critical systems. To further facilitate

progress on the solenoid systems the PAC recommends that the scope of the MTF be broadened to include solenoid R&D. The PAC also encourages the collaboration to explore joint collaboration with the "mu2e" initiative at Fermilab on these magnet systems since the design and implementation has much in common.

Detector R&D:

The proponents discussed plans to explore emerging crystal calorimeter technologies that could satisfy the calorimetry requirements of the experiment. The proponents are interested in developing a high resolution calorimeter, approaching dE/E of 1%, which in principle could provide an important redundant measurement of the putative decay electron momentum when combined with measurement by the spectrometer at the 0.5% level. While such high performance calorimetry would be welcome, it is technically very challenging to deliver this level of energy resolution for 100 MeV decay electrons. The PAC encourages the collaboration to refine the calorimetry requirements and justifications for the COMET experiment to determine what the critical performance parameters are, and to assess the risk to the experiment if these parameters are not met.

Collaboration Growth:

The COMET leadership has been working hard to strengthen the breadth and depth of the collaboration. Examples include recent discussions with the JINR group on calorimeter R&D, and the formation of focused workshops in the UK and Switzerland, and continued collaboration with the "mu2e" initiative at Fermilab. The PAC is pleased to see that this process has been initiated since accomplishing the COMET experiment will require a sizeable collaboration.

3. **E14:** Proposal for $K_L \rightarrow \pi^0 \nu\bar{\nu}$ Experiment at J-PARC (The KOTO Experiment)

The PAC heard a report from FIFC concerning the compatibility of the K1.1 and K0 beam lines and plans for the K0 beam survey. Simulation studies have shown that the presence of the magnet of the K1.1 beam line acts effectively as a collimator and reduces the halo-to-core neutron ratio in the K0 beam line by 60%. In addition, the presence of the K1.1 magnet does not reduce the flux of K^0_L because a separate downstream collimator defines the aperture of the neutral beam. Therefore, the coexistence of the K1.1 and K0 beam lines has been demonstrated in principle.

The Laboratory is supporting the plans for a K0 beam survey in the fall of 2009. The survey is meant to optimize the final beam line and to clarify the large spread in the predictions of the K^0_L and neutron fluxes. The FIFC report stressed the importance to freeze the design of the collimators as soon as possible and urged the E14 Collaboration to seek KEK mechanical engineering support to procure the beam elements necessary for the survey by the end of JFY08.

For this beam survey, the E14 KOTO Collaboration proposes to measure the K^0_L flux from $K^0_L \rightarrow \pi^+ \pi^- \pi^0$ events reconstructed by using two arrays of CsI blocks and two fine grained plastic hodoscopes placed at an optimized position downstream of the final collimator. At present, the precision that can be achieved to determine the yield of neutral kaons per incoming proton is not yet clear. The PAC believes that issues such as redundancy, the absolute normalization, the sensitivity to the beam stability, the acceptance and the reconstruction efficiency must be understood in order to make the beam survey conclusive. The PAC regards the beam survey as the critical next step in advancing the experiment.

The Collaboration reported that detector R&D is continuing. Significant progress was reported on the shipping of the CsI KTeV blocks from Fermilab to Japan. Improvements to the barrel and beam veto system were presented. Prototype electronics for the CsI are available and the Collaboration plans to test about 100 CsI blocks in a test beam during 2009.

The PAC was informed by the IPNS Director that the Stage 2 approval recommendation formulated at previous meetings will be considered after the 2009 beam survey.

4. **E06:** Measurement of T-violating Transverse Muon Polarization in $K^+ \rightarrow \pi^0 \mu^+ \nu$ Decays (The TREK Experiment)

The PAC heard a report from the E06 (TREK) experiment. Estimates for systematic biases associated with possible “local misalignments” in the polarimeter were shown. In particular, the effects of wire displacements and non-uniform chamber inefficiency were investigated in a Monte Carlo simulation. The committee encourages the experimental group to continue the study with higher statistical accuracy. The committee appreciated this work, which confirms that the proposed sensitivity can be reached, and looks forward to the beam test of the prototype polarimeter. The PAC was informed of the TREK funding situation. A grant

application to fund the construction and operation of the experiment will be submitted in the near future. Some funding from the international partners continues to be available for R&D activities.

5. **E11:** Tokai-to-Kamioka Long Baseline Neutrino Oscillation Experimental Proposal (The T2K experiment)

There has been impressive progress over the past six months on the T2K experiment in all areas including the accelerator, neutrino beam line, and the neutrino detectors. The schedule is set for an initial one-month low intensity (below 7.2 kW) neutrino beam run to start in April 2009 with part of the near INGRID detector and the full Super-K detector operational. This run is a major milestone and will allow the testing of the neutrino beam horn magnets as well as the primary proton and some of the neutrino beam monitoring. Even at these low intensities, significant flux will be available at the near detector for the start of commissioning.

An initial data run is expected to start in December 2009 with higher intensity ($\geq$100 kW). For this running period, most of the near detector elements should be operational with the exception of the P0D detectors. As stated earlier, the problem with ripple on the MR magnet power supplies causing poor beam survival is being reduced by rewiring and the application of extra filtering. With these changes, the ability to run the T2K experiment at the 100 kW level is achievable. Therefore, for the T2K experiment, the current main ring performance should allow the collaboration and laboratory to reach the critical milestone of collecting data for 10^7 seconds with 100 kW beam by the summer of 2010.

The work on the T2K neutrino beam line is on schedule for the April 2009 commissioning run. The magnets for the transport line have been installed and the superconducting magnets will start to be cooled on January 2009. The beam monitoring hardware is also scheduled to be completed by March 2009. All three horns for the neutrino beam system have been delivered and testing is ongoing. A first horn replacement exercise is scheduled for November 2008 and the beam line data acquisition system will start commissioning in December 2008.

At Super-K, the detector is fully operational and the new electronics and data acquisition has been running since September 2008. The collaboration is now in the process of doing a recalibration with the various systems available at Super-K.

For the near ND280 detector, the UA1 magnet installation was completed in June 2008 and there have been some checks of the coils with no indication of problems. The ordered power supplies for the magnet appear to only allow reaching a field of 0.15 T whereas the planned field was to be at 0.2 T. In order to hold the schedule to start the data run in late 2009, the field map of the magnet must be completed in July 2009. The collaboration is considering several options and the PAC looks forward at the next meeting, to hearing more information on the possible decision and impact to the ND280 physics capabilities. On general grounds, it would seem unfortunate if this scheduling problem led to a permanent reduction of the ND280 magnetic field but the impact on the T2K physics program needs to be looked at quantitatively.

Funding for all of the ND280 detector elements have now been secured and most elements are starting into production. All electronics are in the production or final prototyping stages and the MPPC photon detectors are being received and tested with almost no bad units. The current schedule, although very tight, indicates that all ND280 detector elements except for the barrel and P0D ECAL units should be ready for the start of the late 2009 data run. The PAC looks forward to another review of the schedule at the next meeting to see if the projected milestones submitted at this meeting continue to hold.

In addition to monitoring the construction progress at the next meeting, the PAC requests that T2K present an initial summary of the goals for the April 2009 commissioning run and how these goals will be accomplished. Also, some initial information on the physics goals for the late 2009 data run along with initial estimates of sensitivities to oscillation signals would be helpful for assessing the goal of obtaining physics results in summer 2010.

6. PROCEDURE OF THE APPROVAL OF SMALL EXPERIMENTS

The IPNS director proposed a scheme for approving small experiments, in response to the previous PAC's recommendation. A committee will be formed to assess experiments, which do not aim to get physics results, such as detector tests, and which do not require a long machine time or large financial support. The committee consists of the leader of the particle and nuclear physics division of J-PARC, the chairperson of J-PARC PAC and the chairperson of the FIFC. The committee will periodically report

the status of these experiments to the PAC as requested. **The PAC endorses this proposal.**

7. DATE FOR THE NEXT J-PARC PAC MEETING

The date for the next meeting is 6-7 March 2009. The tentative agenda is;

- Status report on J-PARC
- Report from the muon task force
- Planning of the K1.8 beamline experiments
- Status report from the KOTO experiment
- Report from the T2K experiment
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8. FOR THIS MEETING, THE J-PARC PAC RECEIVED THE FOLLOWING DOCUMENTS:

- Minutes of the J-PARC PAC meeting held on 7-9, June 2008 (KEK/J-PARC-PAC 2008-5)
- Proposal for Extinction Measurement of J-PARC Proton Beam at K1.8BR (KEK/J-PARC-PAC 2008-6)
- Reply from P23 on the questions raised by PAC (KEK/J-PARC-PAC 2008-7)
- P23 Proposal update (KEK/J-PARC-PAC 2008-8)
- Progress Report to the 6th J-PARC PAC meeting by E06(TREK) Collaboration (KEK/J-PARC-PAC 2008-9)
- FIFC report (KEK/J-PARC-PAC 2008-10)