Eminent figures including two Nobel Laureates, Makoto Kobayashi and Masatoshi Koshiba, on the stage of the inauguration ceremony of J-PARC, which was held at Kudan Kaikan in Tokyo on July 6, 2009.

First neutrino event measured at Super-Kamiokande, which is located 295 km away from J-PARC.

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# J-PARC Annual Report 2009

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This is the second Annual Report of the Japan Proton Accelerator Research Complex (J-PARC), which covers the period of fiscal year 2009. During this period, J-PARC was finally completed, with neutrino beams in April of 2009 (after the neutron, muon and kaon beams in the preceding fiscal year). We have moved, for the first time, into full operational mode.

The first achievement in this fiscal year was the successful operation of 120 kW at 3 GeV. Prior to the summer of 2009, we have suffered for a long time from an RFQ problem (involving one of the Linac elements). Utilizing the summer shutdown we improved the vacuum of the RFQ system and finally solved the major problem. At this moment, the availability of the accelerator is up to 90-95%.

Also, the first neutrino beam was detected at SuperKamiokande in February 2010. Since then, the neutrino data acquisition has been progressing rather smoothly.

In the hadron hall we obtained a very good kaon separation with a static separator. A high efficiency for slow extracted beams of up to 98.5% was reached in the Main Ring. Many experimental groups are preparing to commence data acquisition using these long-spill beams from the Main Ring.

Concerning the 3 GeV, a smooth operation of beams of up to 120 kW produced many productive data for both muons and neutrons. Specifically, the
neutron beam lines have already produced data in several areas including magnetism, distortion, complicated crystal structure, protein and other molecular data, etc. Some data have already been published and many other results are being prepared for publication. Currently, 18 out of 23 beamlines have already received funding for neutrons, while only one beam line out of four has been funded for muons.

One of our goals is to make this facility available internationally. We made a lot of effort to internationalize the J-PARC facility. First, the Users Office has been strengthened. We are building new lodging (about 50 dorm rooms will be completed in December 2010). We are asking the local Village and the local Government to cooperate with us in accommodating a large number of foreign visitors. In addition to the internationalization, efforts have been made as well to open this facility to industrial companies. Finally, the central Government has been constantly supporting J-PARC by increasing the amount of funding.

From now on, our most important mission will be to produce the best scientific results from J-PARC.

Shoji Nagamiya
Director of the J-PARC Center
Accelerators

Linac
3 GeV RCS
50 GeV MR
Overview

The main events of the accelerators’ operations are summarized in Table 1. The first half of the time was spent on conditioning and improvement against the discharge of the radio-frequency quadrupole (RFQ) linac with efforts to show a maximum performance under the miserable situation. This effort resulted in steady progress of the recovery from the discharge and the 120-kW operation of rapid cycling synchrotron (RCS) for Materials and Life Science Experimental Facility (MLF) user runs started in November 2009. Then the 300 kW operation (2.7 × 10^{13} protons/pulse) for MLF was successfully demonstrated on December 10th. This operation was limited to one hour, from 10:45 to 11:45, because the maximum intensity officially permitted was 250 kWh in every hour.

The beam services of Main Ring (MR) started in October to Hadron target and in November to Neutrino target, the typical beam power levels were 1.2 kW and 20 kW with 6 bunches, respectively. The tuning of MR-Fast Extraction (MR-FX) toward 100 kW power had been in progress. On February 27th, 7.3 × 10^{13} protons were extracted to the Neutrino target that corresponds to 100 kW if operated with a repetition period of 3.52 s.

The availability was ~ 92.4% in MLF user runs from November (Run #27) to January (Run #29) for the total beam-on time of 842.3 hours. The statistics of accelerators' operation are 253 days in total, 69 days for MLF user runs, 24 days for Hadron and 24 days for Neutrino.

Table 1. Operation schedule and typical achievements in fiscal year 2009.

<table>
<thead>
<tr>
<th>Month</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run #</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>LINAC Beam mA</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>msec</td>
<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
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<tr>
<td>RFQ Conditioning (for recovery)</td>
<td>Trial of Continuous Operation (results in successful recovery)</td>
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<tr>
<td>Power (approved)</td>
<td>6 kW</td>
<td>(250 kW)</td>
<td>20 kW</td>
<td>120 kW</td>
<td>12 / 10: 300 kW × 1 hr</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MR Study</td>
<td>Official Investigation</td>
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<td></td>
</tr>
<tr>
<td>MR - Slow Ext. Achieved Power</td>
<td>(5 kW)</td>
<td>1 kW ~ 3 kW</td>
<td>12 / 7: K0 Beam</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>MR - Fast Ext. Achieved Power</td>
<td>(1.2 kW)</td>
<td>20 kW (=&gt;50~100 kW)</td>
<td></td>
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</tr>
<tr>
<td>First Beam (Maximum performance under miserable situation)</td>
<td>11 / 22: Events @ Near Detector</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>2 / 24: @ KAMIOKANDE</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
The costs and issues were reinvestigated for the designed goal of 1 MW in RCS and 0.75 MW in MR-FX by taking into account the construction time and the necessary progress in the understanding and control of the beam. The essence is summarized in the following figure and table.

![Fig. 1. Road to 1 MW in RCS and 0.75 MW in MR-FX.](image)

**Table 2. Schedule of Linac, RCS and MR.**

<table>
<thead>
<tr>
<th>JFY</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
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<tbody>
<tr>
<td><strong>LINAC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 MeV</td>
<td>Components Construction</td>
<td>Installation High Power Test</td>
<td>Construction</td>
<td>Installation</td>
<td>Beam Commissioning</td>
<td>Operation</td>
<td>Operation</td>
</tr>
<tr>
<td>[Peak Current 50 mA] System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RCS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 MeV Inj.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Construction &amp; Tuning</td>
<td>Beam Commissioning / Operation</td>
<td></td>
</tr>
<tr>
<td>Correction Mag.</td>
<td>Machine Study &amp; Design</td>
<td>Construction / Installation / Beam Commissioning / Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12th RF Cav.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Construction &amp; Installation</td>
<td>Beam Commissioning / Operation</td>
<td></td>
</tr>
<tr>
<td><strong>MR Installation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RF Cavity</td>
<td>Cavity #1 - #4.</td>
<td>Cavity #5.</td>
<td>2nd Harmonic Cav. #1</td>
<td>Cavity #6.</td>
<td>2nd Harmonic Cav. #2</td>
<td>2nd Harmonic Cav. #3</td>
<td></td>
</tr>
<tr>
<td>Injection</td>
<td></td>
<td></td>
<td>Septum Magnet #1</td>
<td>Septum Magnet #2</td>
<td>Septum Magnets</td>
<td>Septum Magnets</td>
<td></td>
</tr>
<tr>
<td>Extraction</td>
<td>Kicker Magnets</td>
<td>Septum Magnets</td>
<td>Septum Magnets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collimator</td>
<td></td>
<td>3-50BT</td>
<td>Ring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many issues to be solved
LINAC

The linac beam test started in November 2006 and a 181 MeV beam was successfully accelerated in January 2007. Since then, the linac has delivered beams for commissioning of the linac itself, downstream accelerators and research facilities. Trip rates for the RFQ, however, unexpectedly increased in September 2008, and this situation has been disrupting the operations of the user runs.

We assumed that the problem came from damages done during the operation and conditioning, because previously we had been operating the RFQ for hundreds of hours without any trouble. After the trouble, we applied several measures such as changing the RF interlock setting, better suppression of unexpected beam injection, reduction of vane voltage and improvement of the vacuum properties.

In March 2009, we added two ion pumps to the RFQ, one turbo molecular pump in the LEBT (Low Energy Beam Transport), an orifice in the LEBT to reduce gas flow, and a moisture filter in the hydrogen gas system of the ion source. For diagnostics we installed a cold cathode gauge and a quadrupole mass analyzer. We undertook a second vacuum system improvement during the summer shutdown. We replaced the oil rotary pumps with oil-free scroll pumps. Also, we replaced the old LEBT chamber with a new clean chamber with a divider plate which had an orifice for differential pumping. A cryopump was installed on the RFQ side and a 1500 l/s turbo molecular pump on the ion source side. In July we began a 10 day baking process to accelerate the degassing (see Fig. 2).

To reduce the unscheduled beam shutdowns, which the users naturally dislike, the conditioning days for RFQ clean up are scheduled in the operational calendar. At first, we set cycles of 2 or 3 days of operation followed by one conditioning day. In November, based on the stable operation of the RFQ at 20 kW in October, we tried to increase the beam power for the MLF user operation; increasing the beam pulse length from 0.1 to 0.2 ms, and the peak beam current from 5 to 15 mA, thus reaching a 6 fold increase from 20 to 120 kW. We were able to deliver a beam to MLF users without incident. In December we demonstrated 300 kW operation for one hour to the MLF. The linac and the RFQ delivered the beam with a pulse width of 0.5 ms, which was the full design specification. The results verified the restoration of the RFQ as well as the 3 GeV RCS performance.

A compromise was made during phase 1 by limiting the linac energy to 180 MeV. Now, funding has been secured to increase the energy of the linac to 400 MeV as originally intended. This is one of the requirements for achieving the predicted 1 MW power level in the RCS or 0.75 MW in the MR. The upgrade process is under control and the installation is planned for the summer shutdown in 2012. Procure-
ment and fabrication of the major components of the 400 MeV energy upgrade are being performed. The R&D module consisting of accelerating and coupling segments with tuners has been built. Off-line high-power tests of the annular-ring coupled structure (ACS) module have been successfully performed. These tests validated the fabrication technology based on simplified machining of the accelerating cells developed for the mass production of the ACS accelerating cells. In addition, the operation of the tuners at high-power level has been successfully demonstrated.

Table 3. Evolution of RFQ and Linac.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>RF/beam widths (µs)</th>
<th>Peak current (mA)</th>
<th>Pwr@MLF (kW)</th>
<th>Condition or Cont. op. days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 2008</td>
<td>Trip rate increase</td>
<td>200/100</td>
<td>5</td>
<td></td>
<td>Very Poor</td>
</tr>
<tr>
<td>Nov.</td>
<td>Improvement: interlock, conditioning, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec.</td>
<td>MR study and MLF user program after conditioning</td>
<td>155/100</td>
<td>5</td>
<td>20</td>
<td>Poor</td>
</tr>
<tr>
<td>Jan.-Feb. 2009</td>
<td>Conditioning and operation user program was cancelled</td>
<td>155/100</td>
<td>5</td>
<td>20</td>
<td>Poor</td>
</tr>
<tr>
<td>Mar.</td>
<td>Vacuum system improvement, Conditioning procedure changed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>Tank level was decreased from 102 to 95%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun.</td>
<td>MLF user program</td>
<td>155/100</td>
<td>5</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Jul.-Sept.</td>
<td>Vacuum system improvement, Cryo, Pumps, baking, oil-free pumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept.</td>
<td>Conditioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct.</td>
<td>MLF user program</td>
<td>155/100</td>
<td>5</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Nov.</td>
<td>MLF user program</td>
<td>255/200</td>
<td>15</td>
<td>120</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Dec.</td>
<td>MLF user program</td>
<td>255/200</td>
<td>15</td>
<td>120</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Dec.</td>
<td>MLF high power demonstration (1 hour)</td>
<td>555/500</td>
<td>15</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Jan. 2010</td>
<td>MLF user program</td>
<td>255/200</td>
<td>15</td>
<td>120</td>
<td>3</td>
</tr>
<tr>
<td>Jan.</td>
<td>Demonstration of continuous operation for 6 days</td>
<td>255/200</td>
<td>15</td>
<td>120</td>
<td>6</td>
</tr>
<tr>
<td>Feb.</td>
<td>MR and HD/NU study, beam delivery</td>
<td>255/200 - 555/500</td>
<td>15</td>
<td>Cancelled</td>
<td>7 to 6</td>
</tr>
<tr>
<td>Apr.-May</td>
<td>MLF and MR(NU) beam delivery</td>
<td>255/200 - 555/500</td>
<td>15</td>
<td>120</td>
<td>13 (Max.)</td>
</tr>
</tbody>
</table>

Photo 1. R&D module of ACS.
RCS

The RCS has been operating for the neutron and muon user program at MLF since December 23rd, 2008. The RCS operations were not only supporting the MLF but also were providing beams for the MR user program. In parallel we took on the challenge to realize higher beam power operations with better stability.

Figure 3 shows the one-hour average power and the integrated power for the MLF user operation in Japan fiscal year 2009. Before the 2009 summer shutdown, the beam power was limited by the front end of about 20 kW, after that shutdown the RCS has been operating at a beam power level of more than 100 kW for MLF users. After the beam delivery operation to the MR and MLF, while the priority was given to their beam tuning, the RCS has also continued further beam studies to achieve higher beam intensity. On December 7th, 2009, the RCS reached beam power of more than 300 kW to the neutron production target with 25 Hz for 1 hour, shown in Fig. 4. There were 3 occurrences of beam drop within an hour, but the operation was eventually stabilized.

The maximum residual activation became a level of about 1.5 mSv/h after 2-weeks user operation with 120 kW and high power operation of 300 kW for 1 hour. These activations were measured through a contact on the vacuum chamber 6 hours after completion of the beam operation. Since the beam loss was proportional to the number of the stripping foil hits from beam studies and simulations, it was concluded that the large angle events with Coulomb scattering made a hot spot at the H0 branch and the entrance of quadrupole focusing magnet (QFM) at the injection section. In order to reduce these beam losses, the number of foil hits should be reduced by a transverse painting injection and by optimization of the foil size. It will be expected that with the new foil, which is to be installed during 2010 summer shutdown, the number of foil hits will be reduced to less than a half.

![Fig. 3. 1-hour average power and integrated power for MLF user operation for this one year.](image)

![Fig. 4. High power operation of 300 kW for 1 hour.](image)
The MR has three-fold symmetry and its circumference is 1567.5 m. Three dispersion-free 116-m-long straight sections are dedicated to “injection and beam collimators”, “Slow Extraction (SX)”, and “RF cavities and fast extraction (FX)”, respectively. The MR is the first large proton accelerator that adopts a lattice configuration with imaginary transition energy. It does not have the transition crossing between the injection and the extraction energies.

The fast extraction system delivers the beam to the neutrino beam line for the T2K (Tokai-to-Kamioka) experiment. The beam commissioning of the neutrino beam line began in April 2009. After intensive beam studies of the MR and the neutrino beam line, the T2K collaboration started the acquisition of physics data in January 2010. The cycle time for the FX operation is 3.52 s including an acceleration time of 1.9 s and flat top of 0.15 s. Beam intensity of 40 kW in maximum was delivered to the T2K experiment by the end of Japan fiscal year 2009.

We have performed a demonstration of high power beam operation of the MR with single shot mode. In this demonstration, the beam is extracted to the abort line by the FX system. Figure 5 shows a typical beam intensity in the high power demonstration together with the kinetic energy of the beam. The number of particles extracted to the abort line is $7.2 \times 10^{13}$ protons per pulse. It corresponds to ~100 kW if operated in the 3.52 s cycle. Beam loss is almost localized on the collimator section in the injection timing. The loss is about $7.7 \times 10^{11}$, which corresponds to ~100 W, while the design capability of the collimator currently is 450 W.

The SX system delivers the beam to the Hadron (HD) experimental facility. In the 2009 summer shutdown, we installed a spill feedback system, which consists of two types of quadrupoles and a Digital Signal Processing (DSP) system. The beam spill signal is fed into the DSP system and current patterns of the correction are sent to the power supplies of the feedback quadrupoles. The quadrupoles, named “Extraction Q” and “Ripple Q” (Photo 2) are designed to make a constant spill shape in the overall time of the extraction and to compensate the fine ripple structures, respectively. Figure 6 shows a typical beam intensity of the SX operation with the feedback system. After the beam acceleration reaches 30 GeV, the beam is extracted for 1.7 s. The cycle time for the slow extraction operation is 6 s. The extracted beam power is 1.9 kW in this figure. The maximum intensity delivered to the HD facility by the end of Japan fiscal year 2009 was 2.6 kW.
Materials and Life Science Experimental Facility
Overview

At the Materials and Life Science Experimental Facility (MLF), 9 neutron instruments are open for general use and 3 are at the commissioning stage in fiscal year 2009. In addition, 6 neutron instruments have been newly budgeted so that a total of 18 beam lines are either working or budgeted out of 23 available ports. At the decay muon line (D-line), the commissioning was started at the D2 instrument while the D1 instrument has been open for general use since preceding fiscal year. About 250 proposals were collected through the year, more than 30% of them were from industrial users.

We are pleased to announce that since November 2009 the proton beam intensity delivered to the neutron and muon production targets was not only ramped up to 120 kW but the high availability at around 86 to 92% was also accomplished for the user program. The 120 kW stable operation has inspired both instrumental scientists and users. Experiments with small-size samples and/or higher resolution experiments, etc., which cannot be carried out with the 20 kW beam, have been realized.

This exciting event came up on December 10th. It was an operation which used beam power of 300 kW, the highest to date. It was found that the neutrons emitted from the hydrogen moderator toward the unit at an solid angle per pulse increased up to $5.1 \times 10^{12}$, and the general purpose $\mu$S$\Omega$ spectrometer (D$\Omega$I) at the surface muon experimental area recorded $4.5 \times 10^6/s$, (1.8$\times 10^5$ per pulse) of surface muons. As shown in Fig. 1, the neutron and the surface muon intensities obtained at J-PARC reached at that moment the world’s highest level compared with other pulsed source facilities.

Unfortunately, from February to March of 2010 the user program was cancelled due to a problem, which occurred in a cryogenic hydrogen loop for moderators. Eventually, the problem was repaired and the user program resumed from May, 2010. The year of 2009 has given us very satisfying experiences and it also stimulated us to take further steps toward achieving an operation with a high power beam.

<table>
<thead>
<tr>
<th>No. of run cycle</th>
<th>Duration</th>
<th>Scheduled Time (h)</th>
<th>Availability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#24-25</td>
<td>09/05/28 18pm - 06/22 07am</td>
<td>394</td>
<td>75.1</td>
</tr>
<tr>
<td>#26</td>
<td>09/10/12 12pm - 10/23 07am</td>
<td>183</td>
<td>84.3</td>
</tr>
<tr>
<td>#27</td>
<td>09/11/10 13pm - 11/26 07am</td>
<td>270</td>
<td>86.3</td>
</tr>
<tr>
<td>#28</td>
<td>09/12/08 12pm - 12/24 07am</td>
<td>273</td>
<td>92.6</td>
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<tr>
<td>#29</td>
<td>10/01/17 13pm - 02/03 10am</td>
<td>297</td>
<td>89.7</td>
</tr>
<tr>
<td>#30-31</td>
<td>Canceled</td>
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Table 1. Beam up rate for user program in the Japanese fiscal year 2009.

![Figure 1. Comparison of neutron and muon intensities among major pulsed neutron/muon facilities in the world (as of December 2009).](image-url)

Low repetition rate of 25 Hz at J-PARC compared to 60 Hz of SNS and 50 Hz of RAL is a reason for the increasing number of neutrons and muons in each pulse. An unique moderator shape and a new neutron absorbing material of Ag-In-Cd alloy also contributed the increase of the neutron intensity. The improvement of the DC separator increased the muon intensity at the D-line.


**Fig. 2.** Status of the neutron and muon instruments at the MLF as of March, 2010.

<table>
<thead>
<tr>
<th>BL</th>
<th>Name of Instruments</th>
<th>Moderator</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL01</td>
<td>4SEASONS : 4D Space Access Neutron Spectrometer</td>
<td>Coupled</td>
<td>In use</td>
</tr>
<tr>
<td>BL02</td>
<td>DNA : Biomolecular Dynamics Spectrometer</td>
<td>Coupled</td>
<td>Under construction</td>
</tr>
<tr>
<td>BL03</td>
<td>IBIX : IBARAKI Biological Crystal Diffractometer</td>
<td>Coupled</td>
<td>In use</td>
</tr>
<tr>
<td>BL04</td>
<td>ANNRI : Neutron-Neucleus Reaction Instrument</td>
<td>Coupled</td>
<td>In use</td>
</tr>
<tr>
<td>BL05</td>
<td>NOP : Neutron Optics and Fundamental Physics</td>
<td>Coupled</td>
<td>Commissioning</td>
</tr>
<tr>
<td>BL08</td>
<td>S-HRPD : Super High Resolution Powder Diffractometer</td>
<td>Poisoned</td>
<td>In use</td>
</tr>
<tr>
<td>BL09</td>
<td>SPICA : Special Sample Environment Neutron Diffractometer</td>
<td>Poisoned</td>
<td>Under construction</td>
</tr>
<tr>
<td>BL10</td>
<td>NOBORU : Neutron Beam-line for Observation &amp; Research Use</td>
<td>Decoupled</td>
<td>In use</td>
</tr>
<tr>
<td>BL11</td>
<td>PLANET : High Pressure Neutron Diffractometer</td>
<td>Decoupled</td>
<td>Under construction</td>
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<tr>
<td>BL12</td>
<td>HRC : High Resolution Chopper Spectrometer</td>
<td>Decoupled</td>
<td>Commissioning</td>
</tr>
<tr>
<td>BL14</td>
<td>AMATERAS : Cold-Neutron Disk-Disector Spectrometer</td>
<td>Coupled</td>
<td>In use</td>
</tr>
<tr>
<td>BL15</td>
<td>TAIKAN : Smaller-Angle Neutron Scattering Instrument</td>
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<td>BL16</td>
<td>ARISA-II : High-Performance Neutron Reflectometer with a Horizontal Sample Geometry</td>
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<td>In use</td>
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<td>VNR : Reflectometer with Vertical Sample Geometry</td>
<td>Coupled</td>
<td>Under construction</td>
</tr>
<tr>
<td>BL18</td>
<td>SENJU : Single Crystal Neutron Diffractometer under Extreme Condition</td>
<td>Poisoned</td>
<td>Under construction</td>
</tr>
<tr>
<td>BL19</td>
<td>TAKUMI : Engineering Materials Diffractometer</td>
<td>Poisoned</td>
<td>In use</td>
</tr>
<tr>
<td>BL20</td>
<td>iMATERIA : IBARAKI Material Design Diffractometer</td>
<td>Poisoned</td>
<td>In use</td>
</tr>
<tr>
<td>BL21</td>
<td>NOVA : High Intensity Total Diffractometer</td>
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<td>Commissioning</td>
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</table>

<table>
<thead>
<tr>
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<tr>
<td>D2</td>
<td>D2 instrument</td>
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Neutron Source

Characteristics of the neutron beam delivered to the users

Since 2008, through operation cycles under low beam power of up to 20 kW, a delegation of neutron measurements has been carried out at the neutron instruments for the purpose of characterizing the neutronic performance of the three distinctive hydrogen moderators arranged at the top and the bottom of the neutron production mercury target. The measured neutron spectral shape and the pulse shape were reproduced very accurately by the calculation using the PHITS code as shown in Fig. 3, proving that the neutronics design calculation was appropriate. The measured data would be useful not only for the users to understand the source characteristics but also for the instrument scientists to examine the beamline components alignment.

Progress of the 3 GeV proton beam transport facility.

The 3 GeV proton beam transport facility (3NBT) has been fully operational since the beam commissioning started and its reliability has been extremely high. The properties of the proton beam, such as β functions and emittances, were studied and confirmed to be very consistent with the original design values.

An activation method was applied to measure the two-dimensional proton beam profile on the mercury target vessel. The residual dose rate is thought to be representative of the beam profile, since the proton beam is very stable. An Imaging Plate has been placed on the proton entrance side of the target vessel and exposed to the radiation from the vessel for a few minutes. The map of the dose rate after the 120 kW beam operation is given in Fig. 4. It was proved that the proton beam was normally distributed both in horizontal and vertical directions and no skew was observed.

The projections of the proton beam profile onto the horizontal and vertical axes can be measured with multi-wire profile monitors (MWPM) in the proton beam window assembly. The MWPM’s are continuously providing data during beam operations, which show beam distributions consistent with the results of the activation method. Their reliable data have been therefore used for proton beam diagnosis.
Demonstration of components’ operation under a 300 kW proton beam

On December 10, 2009, the neutron production mercury target experienced the high power proton beam operation at 300 kW for the first time. It was a short-term test operation which took only one hour. Nevertheless, we recorded promising performance data for the target vessel and the cryogenic hydrogen loop for moderators towards the operation under the rated beam power of 1 MW. The cryogenic hydrogen loop activated its pressure control system through a passive volume control using an accumulator and a heater so that the pressure change caused by the heat deposition of the secondary particles could be suppressed as designed. The measured pressure fluctuation for the 300 kW proton beam injection was about 15 kPa at maximum, which suggested that the estimated value at the 1 MW beam operation could be lower than the design criteria of 50 kPa.

![Pressure control in the cryogenic hydrogen loop through a passive volume control using an accumulator and a heater at 300 kW beam operation.](image)

Progress of the next generation Mercury target development

The microbubble injection technology for mitigating pressure waves induced in the mercury flowing target vessel has been in the process of successful development. The multi type swirl bubbler producing micro-bubbles with optimal radii less than 50 µm for the pressure wave mitigation was developed and demonstrated using the real size mercury loop at the Oak Ridge National Laboratory under a joint venture research and development of the spallation neutron source between J-PARC and SNS. The experimental results indicated that a proper amount of microbubbles could be distributed in the target vessel through the proper arrangement of the bubbler installation position.

On the other hand, the first spare target vessel (see Photo 1) and its storage container were prepared, in which the issues of the fabrication of the existing target vessel were scrutinized. The structure design of the rear part was revised to eliminate the outer shroud and the inner mercury vessel was substituted by thick pipes to reduce the fabrication cost without sacrificing safety. We are in the process of designing a next-generation target whose rear part can be separated from the front portion.

![Spare target container.](image)

![Target model used for performance tests of microbubble injection device.](image)
Neutron Science

Status of instruments

In fiscal year 2009, we called the J-PARC general user proposals for nine instruments, 4SEASONS (BL01), iBIX (BL03), SuperHRPD (BL08), NOBORU (BL10), AMATERAS (BL14), ARISA-II (BL16), TAKUMI (BL19), iMATERIA (BL20), as well as the Ibaraki prefecture general user proposals for industrial uses in iBIX and iMATERIA. The commissioning of NOP (BL05), HRC (BL12), BL21 (NOVA) is in an advanced stage and these instruments are expected to be available for general use in the next year. Construction of the following six instruments has already started: DNA (BL02), SPICA (BL09), PLANET (BL11), TAIKAN (BL15), VNR (BL17), and SENU (BL18). Those 18 instruments are shown in Fig. 2. During the instrument construction, we made a progress in the development of the computing environment (data acquisition, analysis, device control, data base and etc.), standardization of sample environment, choppers (T0, Fermi and disk choppers) and other devices.

New measurement with event-recording data acquisition system

An event-recording system is essential for RRM because the flexible setting of the Time-of-Flight time channel width realizes a reasonable energy resolution of each $E_i$. The first demonstration result on 4SEASONS (BL01) of the RRM technique by a Fermi chopper spectrometer is shown in Fig. 6, it proved its high potential in inelastic scattering measurements. The result was published as the honorable first paper with neutron scattering data in MLF [M. Nakamura et al., J. Phys. Soc. Jpn. 78 (2009) 093002].

The observations of time-transient phenomena are also a good target of the event-recording system. Figure 7 shows an in-situ experiment program with changing temperature and (compressive) load (a), and diffraction pattern (b) obtained during the measurement Takumi (BL19). In this case, the heating/compression test is conducted in a synchronized time during diffraction measurement. The data are sliceable according to time, temperature, load or statistics. The event-mode system is very useful for such type of measurement in the sense that we can manipulate data even after the measurement is finished, and this will let us take a maximum advantage of the diffraction data.

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**Fig. 6.** Magnetic scattering spectra of CuGeO$_3$ below the spin-Peierls transition temperature measured on 4SEASONS, where the data at 4 different incident neutron energies of (a) $E_i = 152.0$ meV, (b) 45.6 meV, (c) 21.6 meV, and (d) 12.6 meV are obtained simultaneously. With decreasing the incident neutron energy $E_i$ the observation range is zoomed up within three steps. The energy resolution at 12.6 meV is 40 times higher than that at 152.0 meV.

**Fig. 7.** Result of the neutron diffraction measurement under high temperature and compression loading. (a) Temperature and compression load profile. (b) Time-TOF 2-dimensional diffraction pattern.
**Water immersion of PMMA**

ARISA-II (BL16) is a reflectometer with horizontal sample geometry. Water immersion and thermal annealing effect is observed through ARISA-II. A deuterated polymer (poly (methyl methacrylate); PMMA) layer was put on a normal polymer film, and the structure changes of the surface polymer layer were observed after water immersion and thermal annealing (Fig. 8). By analyzing these data, it was shown that the annealing effect of these two treatments were almost the same (Fig. 9), even though water is a non-solvent for PMMA. [A. Horinouchi et al., Chem. Lett. 39 (2010) 810-811.]

**Internal strain of superconducting cable**

Residual strain measurements in the International Thermonuclear Experimental Reactor (ITER) Toroidal Field (TF) conductor (Photo 3) was investigated on TAKUMI (Photo 4). The ITER TF conductor is a Cable-In-Conduit Conductors (CICC) composed of 900 Nb<sub>3</sub>Sn strands, 522 copper strands, a central spiral and a type 316LN stainless steel circular jacket. Although it is well known that the superconducting properties of Nb<sub>3</sub>Sn strands vary significantly depending on the presence of the internal strain, the internal strain of strands in the conductor has not been measured so far because of the cables’ configuration, their location in a jacket and the low volume fraction of Nb<sub>3</sub>Sn.

Due to its high intensity and low background, TAKUMI has successfully measured the diffraction peaks of Nb<sub>3</sub>Sn phase. The observed peaks from Nb<sub>3</sub>Sn phase were subsequently fitted to determine the lattice spacing, and then the reliable residual strains could be evaluated by comparing with the strain-free Nb<sub>3</sub>Sn filament extracted from the ITER TF conductor (Fig. 10). Further results have been reported [T. Hemmi, et al., submitted to IEEE Trans. Appl. Supercond.]. Data from the neutron diffraction experiments herewith can be anticipated to help clarifying strain states in coils for 100 kA class fusion reactors.
Muon Science

Muon beam lines and their optimization and improvement

After the extraction of the first muon beam in the summer of 2008, the Muon Science Establishment (MUSE) group at J-PARC has been optimizing the magnet settings and parameters to maximize the intensity of the muons extracted in the Decay Muon line (D-line).

The muon beam profile monitor (MBPM), which consists of two sets of 16 scintillator strip arrays positioned perpendicular to each other (Fig. 11) is a powerful tool to determine the location and the shape of the muon beam. [P. Strasser et al., Phys. Conf. series 225, 012050 (2010).] The advantage of the beam profile monitor is its response speed; it returns the beam profile instantly, in contrast to an imaging plate (IP) that requires an off-line readout process using a dedicated machine. The electric current settings of the 18 quadrupole magnets, 3 bending magnets and one superconducting solenoid magnet have been optimized according to the beam profile measured by MBPM (Fig. 12).

During the analysis and optimization of the beam line components, it became clear that the gap between the electric plates (10 cm) of the electrostatic (DC) separator is too small to accept the full muon beam profile. We manufactured a new DC separator with a wider gap of 20 cm (Photo 5), and installed it in the D-line in the summer of 2009.

![Fig. 11. Schematic view of the muon beam profile monitor](image1)

![Fig. 12. Muon beam profile measured by the profile monitor (in X and Y) and imaging plate.](image2)

![Photo 5. New electric DC separator with widened gap.](image3)
In the pulsed muon facility, the time width of the muon beam bunch limits the maximum timing resolution of the experiment. By slicing the muon beam in time, the timing resolution could be improved. We manufactured and installed in the D1 experimental area a muon beam slicer, which generates a pulsed electric field (E) applied perpendicular to a stationary magnetic field (B). The muon passes through the slicer only when both the E and B fields are in effect. In 2009, we confirmed that (1) one of the double bunch in a muon beam pulse can be selected by the slicer, and that (2) the single bunch may be sliced down to the width of 37 ns in FWHM. [W. Higemoto et al., J. Phys. Conf. series 225, 012012 (2010).]

The double bunch of the muon beam will be separated and sent to the D1 and D2 experimental areas simultaneously when a pair of kicker and septum magnets is installed at the last bending magnet position of the D-line. The designing, manufacturing and testing of this device is underway.

**Experimental Proposals and general use beam time in MUSE**

For general use of the muon beam, nineteen experimental proposals were accepted in 2009A and B period. Out of 81 days of operation of MUSE, 49 days were dedicated for these general use experiments.

**First scientific paper from J-PARC**

Iron arsenide and pnictide superconductors, which were first reported by Prof. Hosono’s group at Tokyo Institute of Technology in 2008, have now become the material with the highest Tc after the discovery of the cuprate high-Tc materials. The fact that iron is the major building block of this material is another reason why scientists are interested in; normally, iron exhibits ferromagnetism, which is a state very different from superconductivity.

Shortly after the first muon beam delivery at the J-PARC MUSE, this new beamline was used in an actual experiment to characterize the magnetism of the newly discovered iron arsenide superconductors.

One of the advantages of μSR among local magnetic probes is its sensitivity to the volume fraction of magnetism (Fig. 13). A presence of a macroscopic phase separation between the superconducting and magnetic phases was observed in Ca(Fe1-xCo)xAsF (x=0.0–0.15). It was reported that the magnetic phase tends to retain the high transition temperature (Tm > Tc), while Co doping induces strong randomness. The volumetric fraction of the superconducting phase is nearly proportional to the Co content x with a constant superfluid density. These observations suggest the formation of superconducting “islands” (or domains) associated with Co ions in the Fe2As2 layers (Fig. 14), indicating a very short coherence length.

The above result has been published and actually became the first scientific paper produced in J-PARC. [S. Takeshita, et al., Phys. Rev. Lett. 103, 027002 1-4 (2009).]

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**Fig. 13.** Volumetric fraction of paramagnetic (w1) and magnetic (w2) components in Ca(Fe1-xCo)xAsF, where the former becomes superconducting below Tc.

**Fig. 14.** Picture of “island” superconductivity obtained by μSR measurement. At the center of circles, the dopant Co ion may locate.
Neutron Device

**Commissioning of two-dimensional neutron detector for iBIX**

A commissioning test on two-dimensional compact scintillation detectors using the neutron-sensitive scintillator and wavelength-shifting fiber technology was performed successfully at IBARAKI biological crystal diffractometer, iBIX, (Photo 6, 7). The detector exhibited a spatial resolution of 1.2 mm with a detector efficiency of 40% for 2.2-Å neutrons.

Dedicated small sized amplifier/discriminator and encoder/signal processing electronics that handle 512 channels were developed and mounted right behind the detector head. This type of detector has a significant impact not only on the data collection efficiency but also on the data quality of the iBIX.

**One-dimensional neutron detectors for TAKUMI**

Eight one-dimensional scintillation detectors (No.3 - No.10) with “ISIS-type” fiber coded method were equipped on the Engineering Materials Diffractometer, TAKUMI, (BL19). It was demonstrated that the detector and the electronics system accomplished excellent performances of a neutron detection efficiency of more than 50% at a neutron wavelength of 1 Å and a gamma-ray sensitivity less than 10⁻⁶ at a gamma-ray energy of 1.3 MeV.

**Micro-pixel neutron detectors**

We developed a gas-based neutron detection system, which reads out individual lines with a micro-pixel detector element, and conducted preliminary neutron irradiation tests. The micro-pixel detector element pulses had a short duration, the full width at half maximum of the pulse being 160 ns. The detection system exhibits spatial resolutions, of about 2.5 mm FWHM, in both the anode and cathode directions at gas pressures of 0.45 MPa for He and 0.05 MPa for CF₄.
**Wideband beam focusing using a precisely fabricated elliptic supermirror**

We developed a one-dimensional elliptic mirror combining a supermirror coated with ion-beam sputtering and precise elliptic surface figured with the numerically-controlled local wet etching process under cooperation between JAEA and Osaka University.

A mirror substrate was prepared by figuring a surface of synthesized quartz glass into a plano-elliptical shape. The focal length is 1050 mm. The mirror size is 90 mm (elliptic) × 40 mm (straight). NiC/Ti supermirror (m=4) was deposited on the elliptic quartz surface. The focused beam width was 0.25 mm in full width at half maximum, almost reproducing the initial beam size defined by the slit. The focused peak intensity was 6 times the unfocused average intensity.

![Fig. 15. Horizontal profiles of a focused and unfocused beam.](image)

**In-situ SEOP polarized $^3$He neutron spin filter**

An *in-situ* spin-exchange optical pumping (SEOP) polarized $^3$He neutron spin filters (hereafter referred as SEOP filter) has been developed at J-PARC to promote studies of magnetic materials and hydrogen contained material structures with pulsed polarized neutrons. Photo 8 shows the setup of the SEOP filter system which is comprised of a diode laser emitter, external cavity optics to narrow the laser wavelength band, laser optics for laser beam shaping and polarization and a solenoid coil with an oven. A diode laser system pumps the nuclear spin of $^3$He atoms continuously, making it possible to keep the polarization degree of the SEOP filter during an experiment. $^3$He gas is encapsulated in an aluminosilicate glass (GE-180) cell. As a result of a neutron transmission measurement, it was confirmed that the degree of $^3$He nuclear spin polarization was 73% for the spin filter cell with 17 atm-cm $^3$He gas. The performance of the SEOP filter system is at a world standard level, and we are ready to apply it to practical neutron scattering experiments at J-PARC.

![Photo 8. Developed in-situ SEOP polarized $^3$He neutron spin filter system.](image)
Particle and Nuclear Physics
J-PARC’s Hadron Hall Takes Step forward to Particle Nuclear Physics Experiments

Hadron Hall is a multipurpose experimental facility for conducting experiments in the field of the nuclear and particle physics. It uses intense secondary kaon and/or pion beams produced by a high-intensity proton beam. This proton beam is “slowly” extracted to create a quasi-DC beam that extends for 2 s out of every 6-s accelerator operation cycle. To accomplish this, the proton beam extracted from the Main Ring (MR) is transported to Hadron Hall through the slow-extraction beamline in the beam switching yard (SY).

Hadron Hall is designed to accept a maximum beam power of 50 GeV at 15 µA (750 kW). The Hadron Facility group is working together with the accelerator group for achieving early beam commissioning. And currently, the maximum beam power that has been achieved stands at about 2 kW at 30 GeV.

The primary proton beam is focused on the production target (T1), which can be either a 6-cm-long platinum (50% loss) or 5.4-cm-long nickel (30% loss) piece. Currently, Hadron Hall’s size is 60 m across and 56 m long along the beam direction. Further plans exist to extend the hall to accommodate a second production target (T2) and beamlines, which will widen the physics scope of Hadron Hall. And to accommodate these plans, the beam-dump is designed to be movable downstream.

The upper-right inset of Fig. 1 shows the layout of the beamlines at Hadron Hall. After the completion of construction in the beginning of January 2009, the first beam was extracted to Hadron Hall on the 27th of that month. Currently, there are three beam lines: K1.8 for separated charged kaon beams up to about 2 GeV/c, a branch of K1.8 called K1.8BR, and KL for neutral kaon beams. The first kaon beam was identified in the K1.8BR beamline, as stated in the 2008 Annual Report.

When beam commissioning resumed in October 2009, the physicists working at Hadron Hall successfully confirmed the charged and neutral kaon production in the newly constructed K1.8 and KL beamlines, respectively.

K1.8 is a charged-particle beamline that can deliver mass-separated beams of up to 2 GeV/c with very high purity, thanks to the double-stage electrostatic separator (ESS) system. The beam spectrometer, that is the last part of the beamline, is designed to achieve a good resolution of $\Delta p/p = 3.3 \times 10^{-4}$ (FWHM), which is remarkable accomplishment. Called the Superconducting Kaon Spectrometer (SKS), it is a high-resolution spectrometer with a large solid angle (100 msr, where msr represents millisteradian) that was moved from KEK to J-PARC and installed at K1.8 to study scattered particles. The SKS, together with the high-purity kaon beam, make the K1.8 beamline the best place to investigate hypernuclei, which are nuclei with one or two strange-quarks in the form of Lambda or other hyperons. As a result of that, the organization planned a large number of spectroscopy experiments with the purpose to elicit deeper insights into the nature of the strong force.

Beam operation began in October 2009, following the completion of construction over the course of that summer. Subsequently, despite the limited beam time available for tuning, enhanced kaons were produced by the ESS system as expected (see Fig. 1). But obviously, further beam tuning will be attempted to achieve even higher purity for both positive and negative charges.

The superconducting magnet of SKS was successfully excited up to 2.45 tesla with a current of 400 A after cooling down. The performance evaluations of both the beamline and SKS on the basis of $\Sigma^-$ production via the reaction with a liquid H$_2$ target (\( \pi^- + p \rightarrow K^+ + \Sigma^- \)) showed a good resolution of 1.7 MeV/c$^2$. Thus, currently, both the K1.8 beamline and SKS are ready for conducting experiments.

The KL beamline is designed to transport only the neutral particles produced in the target by the proton beam by sweeping charged particles away using a dipole magnet. The KOTO group (J-PARC Experiment E14) designed and constructed the new beamline to generate a narrow neutral beam (called a “pencil” beam) by using two stages of a metal collimator. The group began a survey of the beam quality in the fall of 2009. Since the neutral kaons cannot be measured directly with the usual methods, they detected the secondary particles: charged pions and photons from kaon decay, reconstructed their primary particle, and calculated the mass. After analyzing the data collected in November, they successfully observed the peak at the neutral-kaon mass (500 MeV/c$^2$) in the reconstructed...
mass distribution, which was consistent with the distribution predicted in computer-simulation studies, and confirmed the presence of neutral kaons in the KL beam line. During the J-PARC operations until February, they continued the survey to improve the statistical precision of the measurement and to obtain the yield and momentum spectrum of the neutral kaons in the KL beamline.

The purpose of the J-PARC E14 KOTO experiment is to find the origin of the broken symmetry between particles and anti-particles (CP violation) by measuring the extremely rare decay mode of the neutral $K$ meson by using the high-intensity beam from J-PARC. The aim is to obtain experimental evidence for the decay process of a long-lived neutral kaon ($K_L$) into a neutral $\pi$ meson and a pair of neutrinos, which is predicted in the Standard Model of particle physics to occur with a rate of once in forty billion. As the next step, the KOTO collaboration will begin detector construction in 2010.

This confirmation of charged and neutral kaon beams with excellent performance clearly marks the start of the long-awaited new Kaon Factory. Concrete physics output could be expected with further improvements in the beam power and quality. The first experiment (E19: Penta-quark search) is planned to start its physics run in the fall of 2010. Furthermore, the new K1.1BR beamline will be ready for test experiments in the fall as well, when the construction is expected to be completed.

Fig. 1. Schematic layout of the beamlines at Hadron Hall. Kaon beams are clearly identified in both K1.8 and KL beamlines.
T2K experiment

Japan fiscal year 2009 was a very important and successful year for the neutrino experiment facility. Its operation started in April 2009, with receiving the first proton beam, and it generated a neutrino beam. The final installation was carried out during the summer shut down, and it resumed operation in November. The first neutrino event in the on-site near detector was recorded with the on-axis detector INGRID on November 22, with the off-axis detector ND280 on December 19, and eventually with the Super-Kamiokande on February 24. We have been collecting data for physics analysis continuously, with the aim to discover the first electron appearance event.

The Tokai-to-Kamioka (T2K) experiment is a second-generation long baseline neutrino oscillation experiment with so-called off-axis configuration. Muon neutrino beam is produced at J-PARC with 2.5 degrees off from the direction to the Super-Kamiokande (SK), travels 295 km across the earth, and is detected by SK. The off-axis beam gives us the highest possible intensity of low-energy neutrinos of interest with less high-energy tail, and enables precise measurements with minimum background. The primary goal of the T2K experiment is to determine the last unknown neutrino mixing angle $\theta_{13}$ by investigating oscillation where muon neutrinos turn into electron neutrinos. Owing to the unprecedented intensity of the neutrino beam, the sensitivity of the T2K experiment is more than one order of magnitude higher than the present upper bound of $\theta_{13}$. If $\theta_{13}$ is sufficiently large to be measured in the early phase of the experiment, the possibility of discovering CP violation in the future will be enhanced.

In April and May, the first beam commissioning to establish the primary proton beam line operation was carried out with one of the three electromagnetic horns installed. The beam-line magnets were tuned to lead the protons to the target with single-shot operation and obtain optimum beam envelope, and thus to reduce beam losses, was carried out together with response study of proton beam monitors. Loss monitors were calibrated using 10^-5 level beam loss caused by Ti foil of profile monitors. All monitors satisfy requirement from 1 kW beam to 50 kW beam: intensity can be measured with 2% precision, position better than 0.5 mm,
size better than 0.5 mm, loss down to a few hundred mW level. The OTR monitor measures the beam position and size at the target front-face reliably. The discrepancy of the measured beam orbit from the design orbit was less than 2 mm. The neutrino beam direction towards SK was tuned within 1–mrad accuracy by monitoring the muon profile center. The continuous operation with 20 kW beam was performed and it was confirmed that the beam loss was small enough. The first neutrino event in the on-site near detector was recorded with the on-axis detector on November 22 as shown in Fig. 3, and with the off-axis detector on December 19.

In January 2010, after installation of a collimator and improvement of underground air-tightness to be prepared for higher-intensity beam, continuous operation to accumulate physics data started. By the end of March 2010, the beam power for continuous operation reached 30 kW, and the number of delivered protons became $3.9 \times 10^{18}$.

The first neutrino interaction at SK on the beam timing was observed on February 24, 2010. The event display of SK detector is shown in Fig. 4. This is one of the most important milestones for the T2K experiment. It also indicated that the timing synchronization between J-PARC and SK worked as expected. Beam intensity has been increasing and we have been accumulating a number of protons on the target as shown in Fig. 5. T2K will accumulate more neutrino events at SK to search for a new type of neutrino oscillation with the world’s best sensitivity.

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**Fig. 3.** First neutrino event measured by INGRID on-axis detector.
Fig. 4. First neutrino event measured by Super-Kamiokande.

Fig. 5. History plot of the number of protons delivered to the target. The red line is the total number of protons, while the blue line shows the number used for physics analysis.
Superconducting magnet for the J-PARC neutrino beam line
J-PARC Neutrino Beam Line Superconducting Magnet System

A superconducting magnet system for the J-PARC neutrino beam line was developed with the contributions and in cooperation of the Cryogenics Science Center of Applied Research Laboratory (ARL) and the cryogenics group at Institute of Particle and Nuclear Physics Studies (IPNS) in KEK. The system consists of 14 doublet cryostats; each contains 2 combined function magnets (SCFM). The SCFM uses two single layer left/right asymmetric coils that produce a dipole field of 2.6 T and quadrupole of 19 T/m. The system installation and commissioning took place from February 2008 to March 2009. The beam operation started in April 2009 and the first neutrino beam was generated on 23rd April. Beamline studies were performed to verify the ratio of the dipole field to the quadrupole field, as well as the SCFM alignment in the beam optics. A beam induced quench test was also performed to verify the operational safety. In both tests, the system showed sufficient performance and safety for the continuation of the beam operation.

The initial beam commissioning continued until June 2009 followed by a scheduled maintenance shutdown. The system resumed operation in the end of September 2009, and since then, the magnets have been kept cold, planned, until the next summer shutdown in 2010. The cryogenic system was stopped periodically for short shutdown (about a week or less) for scheduled maintenance. During those short shutdowns the magnets warmed up to about 100 K, so that re-cooling was rapid (for 3 to 4 days), and then a small enough amount of helium gas was kept in the tunnel to ensure safety during the maintenance work. During the continuous operation period, significant efforts were made to minimize the power consumption of the helium refrigerator, which was major part of the remaining power consumption after achieving substantial power savings by using the superconducting magnet system. Figure 1 shows the trends of the various parameters of the helium refrigerator during the transition from the normal mode to power saving mode. The power saving was achieved by reducing and optimizing both the helium-gas flow capacity and the outlet pressure of a main compressor of the refrigerator. After multiple tuning efforts, the automatic transition operation was accomplished, and the power consumption was brought down to 420 kW from 600 kW, or by one third, corresponding to a reduction of the carbon dioxide emissions by about 70 ton per month.

![Fig. 1. Trend curves of various parameters during the transition from the normal mode to power saving mode.](image-url)
In collaboration with the Muon Science Division of Institute of Materials Structure Science in KEK, we developed a superconducting curved solenoid for the Super-Omega muon beam line, one of four secondary muon beam lines at the Materials and Life Science Experimental Facility (MLF) in J-PARC. The beam line starts to extract the beam 45° into backward angles from the production target to transport the surface $\mu^+$ and cloud $\mu^-$ to the MLF experimental hall 2. Once the beam line is completed, it will produce the highest intensity pulsed muon beam ever achieved in the world, with $4 \times 10^8 \mu^+/s$ and $10^7 \mu^-/s$, and it will be used primarily for producing an ultra-slow muon beam. The beam line contains a superconducting solenoid magnet system including 45° curved solenoid sections to transport the high-quality muon beam. Since Japan fiscal year 2008, the R&D for the curved solenoid has been carried out and various model coils have been fabricated as shown in Photo 1. In Japan fiscal year 2009, we conducted intense studies for quench protection and safety of the superconducting solenoid coils. During the studies, a new protection design so-called "passive self-quench back scheme" was confirmed to work very well. Based on this experience, the same design is being applied to a newly renovated muon beam line (Muon Science International Center: MUSIC) at the Research Center for Nuclear Physics (RCNP) in Osaka University.

Photo 1. Cryogenics setup for testing super omega curved solenoid model coil.
Superconducting Magnet R&D for COMET Experiment

A new experiment, COherent Muon to Electron Transition (COMET) has been proposed to search for coherent neutrino-less conversion of muons to electrons using the high intensity proton beam from J-PARC Main Ring. The Cryogenics section has been involved in the COMET experiment to contribute to the development of the superconducting magnet system. In Japan fiscal year 2009, a conceptual design of the magnet system was established, as shown in Fig. 2, and several R&D works were carried out. An important milestone was the development of the prototype aluminum stabilized NbTi superconductor for the so-called “pion capture solenoid” with an inner diameter of 1.6 m and a central field of 5 T.

![Fig. 2. Schematic view of a superconducting magnet system for the COMET experiment.](image)

High Precision Superconducting Solenoid R&D for Muon g-2 Experiment

The anomalous magnetic moment of the muon is directly sensitive to electromagnetic, strong, and weak forces, and the precise measurement of g-2 might lead the new physics beyond the standard model. The experiment at J-PARC to measure the g-2 value with a very high sensitivity level of 0.1 ppm has been proposed by the group in the Institute of Particle and Nuclear Physics Studies, IPNS. A very high precision superconducting solenoid magnet is expected to play an important role in the storage of muon beams in this experiment, the development started in cooperation between IPNS and the Cryogenics section in fiscal year 2009. The required specification is very challenging, it consists of a central magnetic field of 3 T with a field variation below 0.1 ppm within a cylindrical storage region of $33.3 \pm 5$ cm in radius, $\pm 10$ cm in height. To achieve such high uniformity, the precision field monitoring system is also required to check the field quality with an accuracy of 0.1 ppm, the prototype of the system was developed in fiscal year 2009 as shown in Photo 2. It will be tested with a 3 T MRI magnet at the National Institute of Radiological Science in the next fiscal year. In addition, a seismic ground vibration at J-PARC MLF has been measured for later mechanical analysis, because the mechanical vibration of the magnet due to the ground vibration might disturb the field uniformity. This vibration measurement will be carried out throughout the year to observe the year-round change.
The Superconducting Kaon Spectrometer (SKS) was installed into the K1.8 experimental area at the J-PARC Hadron Hall. The SKS system and its schematic flow are shown in Fig. 3.

After the system was built, the superconducting magnet was cooled-down and the liquid helium volume in the magnet has been kept at even level by using a set of GM and GM/JT cryocoolers. The magnet has successfully passed system commissioning. Then the magnet has been used for physical experiments since November 2009.

**Fig. 3.** The Superconducting Kaon Spectrometer (SKS) magnet with three GM-JT cryocoolers to maintain the LHe level and three GM cryocoolers for the shield cooling.
Cryogen Supply and Technical Support at Tokai Campus

The cryogenics section has also started to supply liquid helium for physics experiments and various development activities in J-PARC. The helium liquefaction facility, with a capacity of 100 l/h, is already owned and operated by the Accelerator division at JAEA for superconducting RF development. The evaporated helium gas is recovered from remote experimental areas to a recovery station provided by KEK to the west of the MLF building. The service started in September 2009, and more than 15,000 liter of liquid helium was supplied as shown in Fig. 4 and most of the evaporated gas was been mostly recovered.

![Fig. 4. Supply of liquid helium for fiscal year 2009.](image-url)
Overview

The J-PARC Information System is a system of computers and networks used to conduct researches in J-PARC. The Information System Section designs, manages and operates the system. The activities of the section consist of running the Infrastructure Network system, Authentication System and Data Base System. The aim for each system is to be both secure and easy-to-use ICT (Information Communication Technology) infrastructure for J-PARC users. In 2009, J-PARC started to utilize KEK’s central computing system for neutrinos, nuclear physics and MLF experiments data analysis and data archive through a SINET3 (http://www.sinet.ad.jp/) (2 Gbps) and IBBN (100 Mbps) backup link which connected Tsukuba and Tokai area.

J-PARC network (JLAN) growth

JLAN is an information and communication infrastructure for J-PARC public users and staff. As shown below, the number of hosts connected to JLAN increased 130% in 2009 and the edge switches of JLAN exceeded 80 devices. It also transparently covers two sites in J-PARC, the Tokai site and Tsukuba site which are about 60 km apart. The SINET3 information network (http://www.sinet.ad.jp/) had linked these sites with 1 Gbps bandwidth since October 2008. Thanks to the support of the Japan National Institute of Informatics (NII), which managed the SINET network, the link bandwidth was doubled to 2 Gbps just before the 2009 autumn RUN and it will be upgraded up to 10 Gbps in Japan fiscal year 2011. Figure 3 shows a track record of the data transfer from Tokai to Tsukuba.

![Fig. 1. Number of hosts on JLAN.](image1)

![Fig. 2. Number of JLAN Edge Switches and Wireless Access Points.](image2)

![Fig. 3. Data transfer rate from Tokai to Tsukuba campus.](image3)
Starting to utilize KEK’s Central computer system

J-PARC does not have its own computing facility, but it is authorized to share with KEK computing resources consisting of 1600 SPECint06 computing power, 150 TBytes RAID disks and 2 PBytes tape libraries in KEK’s Central computer system at the Tsukuba site. Figure 4 depicts the system structure. In the Neutrino and Hadron experiments, data taken in the J-PARC experimental hall will be temporarily saved at the Tokai site and promptly transferred to, stored and analyzed in the Tsukuba system. The storage of the system will be utilized as a data archive for MLF experiments. Figures 5 to 8 shows the utilization records of the system in 2009. The Hadron users who used the system constantly were users who continue their experiment in series from the former KEK 12 GeV Proton synchrotron to J-PARC. The Neutrino users just started to use the system after the autumn run and gradually began to store data. The MLF users still seem to be satisfied with the local computing resources at the Tokai area.

Fig. 4. KEK's Central Computer System. (this figure includes resources for users other than J-PARC)

Fig. 5. CPU utilization of KEK’s central computer by J-PARC users.

Fig. 6. Number of Logins by J-PARC users.
Fig. 7. Disk utilization by J-PARC users.

Fig. 8. Tape utilization by J-PARC users.
Observation of a sample using an scanning electron microscopy

Preparation for an experiment at JLBL-4
(JAEA Lead Bismuth Loop-4)

Transmutation Studies
International ADS Workshop

A workshop titled “Accelerator-driven Transmutation System for Young Scientists and Engineers from Europe and Asia”, covering the Accelerator-Driven System (ADS), was held from December 1st through 4th at the Tokai-site of JAEA in cooperation with J-PARC, the Nuclear Science and Engineering Directorate, and the Nuclear Technology and Education Center (NuTEC). The workshop was organized as a part of the research cooperation between JAEA and the European ADS project called EUROTRANS, and also as a part of a training course of the European Nuclear Education Network (ENEN) with which NuTEC is in collaboration. Moreover, this event was organized as the 7th workshop of the Asia ADS Network as well. It was open to young scientists from Asian and European countries, 55 participants attended, including 32 foreign attendees from 15 countries. The four lectures given during the workshop covered research fields related to ADS and research activities for ADS in Japan, China, Korea, and Europe. Moreover, the young participants presented 20 papers, and actively discussed important issues about ADS and the international collaboration actively discussed. In a technical tour, the participants visited Materials and Life Science Experimental Facility and Hadron Hall in J-PARC.

Activities

Corrosion test under flowing Pb-Bi

The JAEA Lead Bismuth Loop -1 (JLBL-1) has been operating for about 10 years with the purpose to investigate the corrosion behaviour of materials in flowing lead-bismuth (Pb-Bi). The experimental results are to be used to develop a beam window and structural materials for ADS. Recently, a corrosion test of solution annealed (SA)-JPCA and 20% cold worked (CW)-JPCA pipe specimen was conducted for 1,000 hours using JLBL-1, TIG welds were applied for joining SA-JPCA and 20%CW-JPCA, and its compatibility in flowing Pb-Bi has also been investigated. The results showed that Pb-Bi penetrated superficially into the matrix of SA-JPCA through a thin ferrite layer formed due to nickel and chromium dissolution. As for 20%CW-JPCA, a dissolution attack occurred only partially, and localized superficial pitting corrosion was observed. We found out that the difference in the corrosion behaviour occurred due to the structure transformation of the austenitic caused by the cold working. By using MFM (Magnetic Force Microscopy), magnetization of the 20%CW-JPCA was revealed as shown in Fig. 1. It was shown that a transformation from austenitic structure to martensitic structure occurred, and it affected the corrosion resistance of the JPCA steel in liquid Pb-Bi. As a next step, corrosion test of the same type materials and high-Cr ODS (oxide dispersion strengthened) has been performed for 3,000 hours.
Post Irradiation Test

To obtain the irradiation data on structural materials of spallation target, the STIP (SINQ target irradiation program, SINQ; Swiss spallation neutron source) has been in progress. Post irradiation examination (PIE) of specimens was carried out at Waste Safety Testing Facility (WASTEF) in the Tokai Research and Development Center, JAEA. The results of the bend-fatigue tests on austenitic steel JPCA indicated that the fatigue life of specimens irradiated up to 19.5 dpa is almost the same as that of unirradiated specimens. Dose dependence of the fatigue life was not observed either.

MEGAPIE

The world’s first megawatt-class lead-bismuth target, MEGAPIE (MEGAwatt Pilot Experiment), was successfully operated and dismantled at the ZWILAG hot-lab. Several meetings on MEGAPIE were held at PSI (Paul Scherrer Institute, Switzerland) in November 2009. In the meetings, the dismantling process of MEGAPIE target and the related hot-lab activities were reported. It became clear that the schedule of the sample cutting and transport will be delayed.

Development of Flow Measurement Techniques

This study* proposes a new technique that enables the measurement of the velocity vector in multi-dimensions on a line in the flow field based on ultrasonic velocity profiling (UVP) method. It was named Vector-UVP. This system was created and successfully applied to an actual liquid metal flow for three-dimensional velocity vector measurements. The schematic illustration and measurement configuration are shown in Fig. 2. The working fluid was LBE which was kept at 150 °C constant. Figure 3 shows an example of the experimental result. The spatial-resolution was 0.88 mm, and the time-resolution was 50 msec. The time-averaged result had an orderly flow like a Poiseuille flow. However, Vector-UVP system was able to measure the instantaneous flow, which had a vortex flow with three-dimensional structure caused by the velocity fluctuation. In the future, this system will accomplish the measurement of the various liquid metal flows in actual temperature conditions by using the high-temperature ultrasonic transducer.

*This study was supported by an innovative nuclear research and development program created by the Japan Science and Technology agency (JST).
Fig. 2. Schematic illustration and configuration for LBE flow measurement.

Fig. 3. Averaged and instantaneous three-dimensional velocity vector profile in LBE loop measured by Vector-UVP system.
J-PARC is a proton accelerator complex with various experimental facilities. It is managed under the Law Concerning Prevention of Radiation Hazards Due to Radio-Isotopes, etc. in the Japanese legal system. A license for its use must be issued by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the related safety inspection must be conducted by the Nuclear Safety Technology Center (NUSTEC), before the accelerator and the experimental facilities begin their operations. The application process for the license started in 2005 for the first phase of construction of the accelerator LINAC. By the end of fiscal year 2008, we have already submitted five applications to MEXT and received the permission to deliver the 3 GeV/250 kW proton beams to Materials and Life Sciences Experimental Facility (MLF), and 30 GeV/1.2 kW proton beams to the Hadron and Neutrino facilities.

In fiscal year 2009, two applications, shown in the table, were submitted to MEXT. In the first application, we applied for the usage of two secondary beam lines (K1.8 and KL) in the Hadron experimental facility and the increase of proton beam intensity of 100 kW for 50 GeV proton synchrotron ring (MR) and Neutrino experimental facility, and of 5 kW for the Hadron experimental facility. We submitted the application to MEXT on June 24, 2009, and all items that we applied for were approved on September 25, 2009. In the second application, which we submitted on January 20, 2010, we requested the usage of a secondary beam line (K1.1BR) in the Hadron experimental facility, and the item was approved on April 1, 2010.

The on-site inspections for the applications of fiscal year 2008 and the first application of fiscal year 2009 were successfully conducted by NUSTEC on May 29, 2009 and December 16, 2009, respectively. Therefore, the secondary beam lines (K1.8 and KL) in the Hadron experimental facility were officially opened for users to conduct beam experiments, and we were able to operate proton beams with an intensity of 5 and 100 kW for the Hadron and Neutrino experimental facilities, respectively. Photos 1 and 2 show the safety inspection conducted by NUSTEC.

The building for radiation measurements (2-story above the ground, 700 m²) was newly constructed (Photo 3). The application for setting up a radiation controlled area in the building was submitted to MEXT, and we received the permission on March 25, 2009. The area will be set up in May, 2010, and the radioactivity in environment will be measured.

In fiscal year 2009, 2154 individuals were registered as radiation workers in J-PARC (about 16% increase compared to fiscal year 2008). The radiation exposure of the workers has been monitored individually with glass dosimeters and solid state nuclear track detectors. According to the records, the individual exposure to radiation for almost all was undetectable, and 0.1 mSv/y was recorded for only 2 workers (staffs).

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<td>MLF</td>
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<td>Neutrino</td>
<td>Max. accelerating particles</td>
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<td>-</td>
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</table>
Photo 1. Safety inspection by NUSTEC (1)

Photo 2. Safety inspection by NUSTEC (2)

Photo 3. Building for radiation measurements
Users Office
Overview

The J-PARC Center Users Office (UO) was set up in 2007 to act as a direct interface between J-PARC and its users, which was thought to be one of the effective ways of making J-PARC user-friendly.

In general, those who would like to request beam time submit their proposals. Once the proposals are accepted, they create procedures for work at J-PARC. After the beam time's completion, they submit experimental reports. J-PARC has introduced a web-based system, which enables them to execute the above processes online. The system consists of proposal submission system, proposal review system, user support system and experimental report submission system. The proposal submission system and the user support system started in 2008. And in 2009 the proposal review system started and the experimental report submission system was developed. The experimental report submission system is scheduled to start its operations in 2010.

The UO had the following tasks in 2009:

1) Procedures for Working at J-PARC
   - User registration
   - Issue of J-PARC User ID Card
   - Issue of Cafeteria Card
   - Issue of Car Driving Permit
   - Procedures for working at radiation controlled area
   - Procedures for Network (JLAN) use in Tokai area
   - Visa application support

2) Daily Life Support
   - Accommodation booking
   - Car renting support
   - Bike lending
   - Offering daily life information

3) User Programs Acceptance
   - Accepting user proposals through the proposal submission system and forwarding them to the Proposal Review Committee

4) Advice Request Acceptance
   - Accepting advice request concerning proposals or technical matters and forwarding them to persons concerned

Status of accommodations

It has been crucial to provide good accommodations for the users. Since its inception the UO, cooperating with other departments concerned, has been making efforts to secure good accommodations. The accommodations available in 2009 are listed with photographs in this section.

Moreover the construction of a new user dormitory with 49 rooms at Ibaraki Quantum Beam Research Center was started. It is scheduled to open in January 2011. The availability of Ohta Danchi Bldg. B and D with 12 apartments (3DK) for more than one month stay was considered as well. They are scheduled to be available in October, 2010.
**Locations of accommodations available in 2009**

(1) **Akogigaura Club**  
for less than one month stay  
Single (western style): 15 rooms  
Twin (western style): 2 rooms  
Single (Japanese style): 8 rooms

(2) **Tokai Bunshitsu**  
for less than one month stay  
Single (western style): 9 rooms  
Twin (western style): 2 rooms

(3) **Masago International Lodging**  
for more than one month stay  
Single (western style): 30 rooms  
Twin (western style): 3 rooms

(4) **Minouchi Jyutaku**  
for more than one month stay  
15 houses (3LDK)

(5) **Ohta Danchi Bldg.C**  
for more than one month stay  
12 apartments (3DK)
User statistics

As a whole the number of the users has been increasing, although it is not an accurately constant increase. The followings are charts showing the number of users who stayed at J-PARC in 2009.

(1) Users in 2009 (according to organizations, person-days)

(2) Users in 2009 (according to facilities, person-days)

(3) Users in 2009 (Japanese people · Foreigners people, person-days)
User Program
1. Proposal Reviewing System for the MLF User Program

Call for proposals for the second half of 2009 (2009B): June 1 – June 19, 2009
The review results were announced in October, 2009.

Call for proposals for the first half of 2010 (2010A): December 1, 2009 – February 7, 2010
The review results were announced in April, 2010.

2. Summary of Applications and Results (MLF)

![Graphs showing the summary of applications and results](image-url)
3. Access Mode for MLF Use

(1) General use
The general use provides both local and international users with opportunities to conduct experiments. A variety of experiments are accepted both for academic researches and industrial applications.

(2) Project use
The project use provides JAEA and KEK with opportunities to conduct their main-task-oriented programs such as inclusive scientific research projects, research programs proposed to fulfill the plans for the midterm goals of JAEA, joint research programs and contract research programs with other institutes or organizations. The principal researchers in the project may request beamtime longer than one year.

(3) Instrument group use
The instrument group use provides the instrument scientists responsible for the beam-line instruments with opportunities to maintain and/or improve the performance of their instruments and conduct leading-edge research and development which would ensure maximum performance of the instruments so that MLF can always provide the users with superior experimental conditions.

4. Process for Approving Experimental Programs in Particle and Nuclear Physics

The eighth PAC meeting was held on July 17 – 19, 2009.
The ninth PAC meeting was held on January 15 – 17, 2010.
5. Approval Summary of the Particle and Nuclear Physics Experiments after the 9-th PAC Meeting (January 17, 2010)

<table>
<thead>
<tr>
<th>Spokespersons</th>
<th>Affiliation</th>
<th>Title of the experiment</th>
<th>Approval status (PAC recommendation)</th>
<th>Slow line priority Day1? Day1 Priority</th>
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<td>K. Tanida</td>
<td>Kyoto U</td>
<td>Measurement of X rays from ( \Xi^- ) Atom</td>
<td>Stage 2</td>
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<td>K1.8</td>
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<td>J.C. Peng, S. Sawada</td>
<td>U of Illinois at Urbana-Champaign; KEK</td>
<td>Measurement of High-Mass Dimuon Production at the 50-GeV Proton Synchrotron</td>
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<td>Primary</td>
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<td>T. Nagae</td>
<td>Kyoto U</td>
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<td>Day1 1</td>
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<td>Measurement of T-violating Transverse Muon Polarization in ( K^+ \rightarrow \pi^0 \mu^+ \nu ) Decays</td>
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<td>K1.1BR</td>
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<td>A. Krutenkova</td>
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<td>Pion double charge exchange on oxygen at J-PARC</td>
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<td>A. Sakaguchi, T. Fukuda</td>
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<td>Production of Neutron-Rich Lambda-Hypernuclei with the Double Charge-Exchange Reaction (Revised from Initial P10)</td>
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<td>T. Kobayashi</td>
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<td>M. Iwasaki, T. Nagae</td>
<td>RIKEN, Kyoto U</td>
<td>A Search for deeply-bound kaonic nuclear states by in-flight ( 3\text{He}(K^-, \gamma) ) reaction</td>
<td>Stage 2</td>
<td>Day1</td>
<td>K1.8BR</td>
</tr>
<tr>
<td>R. Hayano, H. Outa</td>
<td>U Tokyo, RIKEN</td>
<td>Electron pair spectrometer at the J-PARC 50-GeV PS to explore the chiral symmetry in QCD</td>
<td>Stage 1</td>
<td></td>
<td>High p</td>
</tr>
<tr>
<td>H. Bhang, H. Outa, H. Park</td>
<td>SNU, RIKEN, KRISS</td>
<td>Coincidence Measurement of the Weak Decay of ( ^{12}\text{C} ) and the three-body weak interaction process</td>
<td>Stage 1</td>
<td></td>
<td>K1.8</td>
</tr>
<tr>
<td>M. Naruki</td>
<td>KEK</td>
<td>High-resolution Search for ( ^6\text{O} ) Pentaquark in ( \pi^- p \rightarrow K^X ) Reactions</td>
<td>Stage 2</td>
<td>Day1</td>
<td>K1.8</td>
</tr>
<tr>
<td>Y. Kuno</td>
<td>Osaka U</td>
<td>An Experimental Search for ( \mu^- - e ) Conversion at a Sensitivity of ( 10^{-16} ) with a Slow-Extracted Bunched Beam</td>
<td>Stage 1</td>
<td></td>
<td>New beamline</td>
</tr>
<tr>
<td>S. Ajimura, A. Sakaguchi</td>
<td>Osaka U</td>
<td>Exclusive Study on the Lambda-N Weak Interaction in ( A=4 ) Lambda-Hypernuclei (Revised from Initial P10)</td>
<td>Stage 1</td>
<td></td>
<td>K1.8</td>
</tr>
<tr>
<td>S. Miura</td>
<td>KEK</td>
<td>Extinction Measurement of J-PARC Proton Beam at K1.8BR</td>
<td>test experiment</td>
<td></td>
<td>K1.8BR</td>
</tr>
<tr>
<td>K. Ozawa</td>
<td>U Tokyo</td>
<td>Direct measurements of ( \omega ) mass modification in ( A(\pi^+, n) \omega ) reaction and ( \omega \rightarrow n\gamma ) decays</td>
<td>Deferred</td>
<td></td>
<td>K1.8</td>
</tr>
<tr>
<td>T. Nagae</td>
<td>Kyoto U</td>
<td>Search for a nuclear Kbar bound state ( K^- p p ) in the ( d(\pi^+, K^-) ) reaction</td>
<td>Stage 1</td>
<td></td>
<td>K1.8</td>
</tr>
<tr>
<td>H. Fujioka</td>
<td>Kyoto U</td>
<td>Study of isospin dependence of kaon-nucleus interaction by ( \omega ) in-flight ( 3\text{He}(K^-, n/p) ) reactions</td>
<td>approved as a part of E15</td>
<td></td>
<td>K1.8BR</td>
</tr>
<tr>
<td>H. Ohnishi</td>
<td>RIKEN</td>
<td>Study of in medium mass modification for phi meson using phi meson bound state in nucleus</td>
<td>Deferred</td>
<td></td>
<td>K1.1</td>
</tr>
<tr>
<td>H. Noumi</td>
<td>Osaka U</td>
<td>Spectroscopic study of hyperon resonances below KN threshold via the ( (K^-, n) ) reaction on Deuteron</td>
<td>Stage 1</td>
<td></td>
<td>K1.8BR</td>
</tr>
<tr>
<td>A. Rubbia</td>
<td>ETH, Zurich</td>
<td>Towards a Long Baseline Neutrino and Nucleon Decay Experiment with a next-generation 100 kton Liquid Argon TPC detector at Okinoshima and an intensity upgraded J-PARC Neutrino beam</td>
<td>test experiment</td>
<td></td>
<td>K1.1BR</td>
</tr>
<tr>
<td>H. Shimizu</td>
<td>KEK</td>
<td>Measurement of Neutron Electric Dipole Moment</td>
<td>Deferred</td>
<td></td>
<td>Linac</td>
</tr>
<tr>
<td>N. Saito, M. Iwasaki</td>
<td>KEK, RIKEN</td>
<td>An Experimental Proposal on a New Measurement of the Muon Anomalous Magnetic Moment g-2 and Electric Dipole Moment at J-PARC</td>
<td>Deferred</td>
<td></td>
<td>MLF</td>
</tr>
<tr>
<td>T. Kajita</td>
<td>ICRR, Tokyo</td>
<td>A test experiment to measure sub-GeV flux in the on-axis direction at the J-PARC neutrino beam</td>
<td>to be Decided by E11 and Lab</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Organization and Committees
Members of the committees organized for J-PARC

(as of March 2010)

1) Steering Committee

Yasuhiro Fujii
Japan Atomic Energy Agency, Japan

Hideo Hirayama
High Energy Accelerator Research Organization, Japan

Yukihide Kamiya
High Energy Accelerator Research Organization, Japan

Satoru Kondo
Japan Atomic Energy Agency, Japan

Shoji Nagamiya
J-PARC Center, Japan

Sohei Okada
Japan Atomic Energy Agency, Japan

Osamu Shimomura
High Energy Accelerator Research Organization, Japan

Fumihiko Takasaki
High Energy Accelerator Research Organization, Japan

Hiroshi Uetsuka
Japan Atomic Energy Agency, Japan

Michio Yamada
High Energy Accelerator Research Organization, Japan

Hideaki Yokomizo
Japan Atomic Energy Agency, Japan

2) International Advisory Committee

Ian Anderson
Oak Ridge National Laboratory, USA

Sergio Bertolucci
CERN, Switzerland

Bernard Frois
CEA-Saclay, France

Hidetoshi Fukuyama
Tokyo University of Science, Japan

Stuart Henderson
Oak Ridge National Laboratory, USA

Young-Kee Kim
Fermi National Accelerator Laboratory, USA

Hugh Montgomery
Thomas Jefferson National Accelerator Facility, USA

Jean-Michel Poutissou
TRIUMF, Canada

Thomas Roser
Brookhaven National Laboratory, USA

Tsumoru Shintake
RIKEN, Japan

Host Stoecker
GSI, Germany

Satoru Tanaka
University of Tokyo, Japan

Andrew Taylor
Rutherford Appleton Laboratory and ISIS, UK

Eiko Torikai
University of Yamanashi, Japan

John W. White
Australian National University, Australia (chair)

3) Users Consultative Committee for J-PARC

Hiroaki Aihara
University of Tokyo, Japan

Yasuhiro Fujii
Japan Atomic Energy Agency, Japan

Toshiharu Fukunaga
Kyoto University, Japan

Yoshiaki Fukushima
Toyota Central R&D Labs., Inc., Japan

Makoto Hayashi
Ibaraki Prefecture, Japan

Tomohiko Iwasaki
Tohoku University, Japan

Shinichi Kamei
Mitsubishi Research Institute, Inc., Japan

Toshiji Kanaya
Kyoto University, Japan

Yoshiaki Kyanagi
Hokkaido University, Japan

Takashi Kobayashi
High Energy Accelerator Research Organization, Japan

Yasuhiro Miyake
High Energy Accelerator Research Organization, Japan

Tomofumi Nagae
Kyoto University, Japan

Tsuyoshi Nakaya
Kyoto University, Japan

Kazuma Nakazawa
Gifu University, Japan

Nobuhiko Nishida
Tokyo Institute of Technology, Japan
Kazumi Nishijima Mochida Pharmaceutical Co., Ltd., Japan
Naohito Saito High Energy Accelerator Research Organization, Japan
Hideyuki Sakai University of Tokyo, Japan
Mamoru Sato Yokohama City University, Japan
Mitsunori Shibayama University of Tokyo, Japan
Hirokazu Tamura Tohoku University, Japan
Eiko Torikai University of Yamanashi, Japan
Kazuyoshi Yamada Tohoku University, Japan
Taku Yamanaka Osaka University, Japan (chair)

4) Accelerator Technical Advisory Committee

David Findlay Rutherford Appleton Laboratory, UK
Roland Garoby CERN, Switzerland
John Galambos Oak Ridge National Laboratory, USA
Stephen Holmes Fermi National Accelerator Laboratory, USA
Akira Noda Kyoto University, Japan
Peter Ostroumov Argonne National Laboratory, USA
Uli Ratzinger Frankfurt University, Germany
Thomas Roser Brookhaven National Laboratory, USA (chair)
Jie Wei Tsinghua University, China

5) Neutron International Advisory Committee

Günter Bauer Forschungszentrum Jülich GmbH (retired), Germany
Stephen Bennington Rutherford Appleton Laboratory, UK
Kurt Clausen Paul Scherrer Institute, Switzerland
John Haines Oak Ridge National Laboratory, USA
Toshihiko Kanaya Kyoto University, Japan
Yoshiaki Kiyanagi Hokkaido University, Japan
Dan Neumann National Institute of Standards and Technology, USA (chair)
Robert Robinson Australian Nuclear Science and Technology Organization, Australia
Kazuyoshi Yamada Tohoku University, Japan

6) Muon Science Advisory Committee

Jun Akimitsu Aoyama Gakuin University, Japan
Hiroshi Amitsuka Hokkaido University, Japan
Robert Cywinski University of Huddersfield
Elvezio Morenzoni Paul Scherrer Institute, Switzerland (chair)
Jean-Michel Poutissou TRIUMF, Canada
Atsushi Shinohara Osaka University, Japan
Jeff E. Sonier Simon Fraser University, Canada
Eiko Torikai University of Yamanashi, Japan

7) Radiation Safety Committee

Yoshihiro Asano RIKEN, Japan
Shuiichi Ban High Energy Accelerator Research Organization, Japan
Hideo Hiryama High Energy Accelerator Research Organization, Japan
Kenjiro Kondo High Energy Accelerator Research Organization, Japan
Takeshi Murakami National Institute of Radiological Sciences, Japan
Tetsuo Noro Kyushu University, Japan
Kotaro Sato High Energy Accelerator Research Organization, Japan
Seiichi Shibata  
Hiroshi Uetsuka  
Yoshitomo Uwamino  
Yoshihiro Yamaguchi  
Makoto Yoshida

8) MLF Advisory Board
Masatoshi Arai  
Kazuhisa Kakurai  
Toshiharu Fukunaga  
Yasuhiro Fujii  
Makoto Hayashi  
Susumu Ikeda  
Yujiro Ikeda  
Ryosuke Kadono  
Shinichi Kamei  
Takashi Kamiyama  
Toshiji Kanaya  
Yoji Koike  
Teiichiro Matsuzaki  
Yasuhiro Miyake  
Junichiro Mizuki  
Nobuhiko Nishida  
Yukio Noda  
Manor Sato  
Hideki Seto  
Mitsuhiro Shibayama  
Hirohiko Shimizu  
Jun Sugiyama  
Junichi Suzuki  
Kazuyoshi Yamada

9) Nuclear and Particle Physics Experiments at the J-PARC 50 GeV Proton Synchrotron Program Advisory Committee (~March 2010)
Augusto Ceccucci  
Hideto Enyo  
Avraham Gal  
Kaoru Hagiwara  
Shunzo Kumano  
Toshinori Mori  
Yasuki Nagai  
Satoshi Nakamura  
Takashi Nakano  
Jen-chieh Peng  
Michael Shavelitz  
Susumu Shimoura  
Robert S. Tschirhart  
Hitoshi Yamamoto  
Katsuo Tokushuku

Kyoto University, Japan (chair)  
Japan Atomic Energy Agency, Japan  
RIKEN, Japan  
Japan Atomic Energy Agency, Japan  
Japan Atomic Energy Agency, Japan  
Japan Atomic Energy Agency, Japan  
Ibaraki Prefecture, Japan  
High Energy Accelerator Research Organization, Japan  
Japan Atomic Energy Agency, Japan  
High Energy Accelerator Research Organization, Japan  
Mitsubishi Research Institute, Inc., Japan  
High Energy Accelerator Research Organization, Japan  
Kyoto University, Japan  
Tohoku University, Japan  
RIKEN, Japan  
High Energy Accelerator Research Organization, Japan  
Japan Atomic Energy Agency, Japan  
Tokyo Institute of Technology, Japan  
Tohoku University, Japan  
Yokohama City University, Japan  
High Energy Accelerator Research Organization, Japan  
University of Tokyo, Japan  
High Energy Accelerator Research Organization, Japan  
Research Center for Nuclear Physics, Osaka University, Professor  
Tohoku University, Graduate school of science, Associate Professor  
Research Center for Nuclear Physics, Osaka University, Professor  
University of Illinois, Dept. of Physics, Professor  
Columbia University, Dept. of Physics, Professor  
CNS, University of Tokyo, Graduate school of science, Professor  
Fermi National Accelerator Laboratory, Research Physicist  
Tohoku University, Graduate school of science, Professor  
High Energy Accelerator Research Organization, ISPN, Physics Division 2, Professor
Budget

Budget Profile (Construction)

Initial Construction (JAEA) = 858 Oku Yen (56%)  
After Construction (JAEA) = 200 Oku Yen incl. > 2010

Initial Construction (KEK) = 666 Oku Yen (44%)  
After Construction (KEK) = 18 Oku Yen incl. > 2010

Notes;  
Operational budget does not include salaries for JAEA and KEK. It includes, however, outsourcing personnel’s.  
A new budget frame was adopted on the basis of the Law for the Promotion of Public Utilization of the Specific Advanced Large Facilities which was established on July 1, 2009.
Main Parameters
## Present main parameters of Accelerator

<table>
<thead>
<tr>
<th>Linac</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerated. Particles</td>
<td>Negative hydrogen</td>
</tr>
<tr>
<td>Energy</td>
<td>181 MeV</td>
</tr>
<tr>
<td>Peak Current</td>
<td>15 mA for user program</td>
</tr>
<tr>
<td>Pulse Width</td>
<td>0.5 ms</td>
</tr>
<tr>
<td>Repetition Rate</td>
<td>25 Hz</td>
</tr>
<tr>
<td>Freq. of RFQ, DTL, and SDTL</td>
<td>324 MHz</td>
</tr>
<tr>
<td>RCS</td>
<td></td>
</tr>
<tr>
<td>Circumference</td>
<td>348.333 m</td>
</tr>
<tr>
<td>Injection Energy</td>
<td>181 MeV</td>
</tr>
<tr>
<td>Extraction Energy</td>
<td>3 GeV</td>
</tr>
<tr>
<td>Repetition Rate</td>
<td>25 Hz</td>
</tr>
<tr>
<td>RF Frequency</td>
<td>0.938 MHz → 1.67 MHz</td>
</tr>
<tr>
<td>Harmonic Number</td>
<td>2</td>
</tr>
<tr>
<td>Number of RF cavities</td>
<td>11</td>
</tr>
<tr>
<td>Number of Bending Magnet</td>
<td>24</td>
</tr>
<tr>
<td>Main Ring</td>
<td></td>
</tr>
<tr>
<td>Circumference</td>
<td>1567.5 m</td>
</tr>
<tr>
<td>Injection Energy</td>
<td>3 GeV</td>
</tr>
<tr>
<td>Extraction Energy</td>
<td>30 GeV</td>
</tr>
<tr>
<td>Repetition Rate</td>
<td>~0.3 Hz</td>
</tr>
<tr>
<td>RF Frequency</td>
<td>1.67 MHz → 1.72 MHz</td>
</tr>
<tr>
<td>Harmonic Number</td>
<td>9</td>
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<tr>
<td>Number of RF cavities</td>
<td>5</td>
</tr>
<tr>
<td>Number of Bending Magnet</td>
<td>96</td>
</tr>
</tbody>
</table>

## Key parameters of Materials and Life Science Experimental Facility

| Injection energy          | 3 GeV                                                                 |
| Repeatability rate        | 25 Hz                                                                 |
| Neutron source            |                                                                      |
| Target material           | Mercury                                                               |
| Number of moderators      | 3                                                                     |
| Moderator material        | Supercritical hydrogen                                               |
| Moderator temperature/pressure | 20K/ 1.5 MPa            |
| Number of neutron beam ports | 23                     |
| Muon production target    |                                                                      |
| Target material           | Graphite                                                             |
| Number of muon beam extraction ports | 4                |
| Neutron instruments       |                                                                      |
| Open for user program (general use) | 9                    |
| Under commissioning/construction | 3/6               |
| Muon instruments          |                                                                      |
| Open for user program (general use) | 1                    |
| Under commissioning       | 1                                                                     |

(*) as of March, 2010
Events

July 6, 2009

Commemoration Ceremony Marks the J-PARC’s Completion

On July 6, 2009, a commemoration ceremony marking the completion of J-PARC was held in KUDAN KAikan, Tokyo. About 900 people attended it, and 60 of them were from abroad. During the ceremony, we announced the completion of the first phase of construction. Mr. Shionoya, Minister of Education, Culture, Sports, Science and Technology, expressed his great expectations for J-PARC, just like many other international guest and researchers.

From left: President Toshio Okazaki of JAEA, Director Shoji Nagamiya of J-PARC Center, Director General Atsuto Suzuki of KEK.

From right: Thom Mason/Director at Oak Ridge National Laboratory, Erich Vogt/Previous Director at TRIUMF, John White/Professor at Australian National University, Dong-Pil Min/Chairman, Korea Research Council of Fundamental Science and Technology (KRCFST), Leonid Ponomarev/Director of Russian MUCATEX and member of the Russian Academy of Sciences.

Researchers from overseas took the stage.
August 1, 2009

*J-PARC Open House*

On August 1, 2009, J-PARC was open to the public, that is, the three accelerators, which were stopped for the periodical summer maintenance (LINAC, the 3 Gev synchrotron, and the 50 Gev synchrotron) and the three experimental facilities (Materials and Life Science Experimental Facility, Hadron Experimental Facility, and Neutrino Experimental Facility). Thanks to the warm weather, there were as many as 4700 visitors (3700 for J-PARC), which was the largest number that we have ever had.

November 9 – 12, 2009

*The International Workshop on Pulsed Spallation Neutron Sources, Tokai, Ibaraki, Japan.*

The neutron source section members of J-PARC and 4 staffs of SNS at Oak Ridge National Laboratory in USA eagerly discussed the common issues concerning the pulsed spallation neutron sources operated with the high power beam of mega-watt on the basis of the operational experiences in both facilities so far. 6 members of the European Spallation Source project team and 9 members of the China Spallation Neutron Source project team also participated in exchanging information for their own planning facilities. The satellite workshop on the cavitation damage mitigation technology for mercury target was also held in parallel on November 11 and 12.
December 1, 2009

Social Gathering with the Foreign Users

On December 1, 2009, many foreign researchers, Mr. Murakami, the Tokai village mayor and people employed by J-PARC assembled for a social gathering. It was a fruitful meeting, at which they discussed their research and impressions of the life in Japan.

March 29 – 31, 2010

The First MLF Symposium, Tokai, Ibaraki, Japan.

Over 220 participants from universities, academic institutes, and companies attended and discussed many topics such as superconductivity, Li-ion batteries, mechanical engineering, protein structures, etc. as well as the progress of neutron source facility, muon target, neutron and muon instrumentations.
Prominent Visitors to J-PARC in 2009

Ikuo Kamei, Upper House Member (April, 27)

Seiko Noda, Minister of State for Science and Technology Policy (July, 3)

Sadakazu Tanigaki, Lower House Member (July, 7)

Masaharu Nakagawa, Deputy Minister of Education, Culture, Sports, Science and Technology (December, 18)

Hudi Hastowo, Head of The National Nuclear Energy Agency of Indonesia (BATAN) (October, 8)

The Committee on Education, Culture, Sports, Science and Technology of the House of Representatives (March, 31)

(Right) Makiko Tanaka, Committee Chairperson

More Than 30,000 People Visited J-PARC

The number of J-PARC’s visitors for the period from April 2005 to the end of January 2010 exceeded 30,000. Regular people and local residents, junior-high and high school students and teachers accounted for the half of that number.

- Public Offices: 22%
- Junior-high/High school students, teachers: 11%
- Business: 11%
- Local residents: 8%
- Media: 7%
- University students, experts: 6%
- VIP, lawmakers: 2%
- Foreigners: 2%
- In-house: 9%

Director Nagamiya, of the J-PARC Center, explains the facility to citizens of Falls, Idaho, the sister city of Tokai village (August 2008).
Summaries of International Advisory Committees

International Advisory Committee

The International Advisory Committee was held on March 15 and 16 in 2010. The committee congratulated the success that all the elements are running nicely. On the other hand, the committee pointed out much smoother organizational structure by having mirror image of the two organizations. In addition, the most urgent issue is to go to 1 MW as quickly as possible. It was pointed out to us that the financial arrangement must be planned carefully and, at the same time, rigorously.

The ninth meeting of Accelerator Technical Advisory Committee (ATAC).

The ninth meeting of ATAC was held on March 11 to 13 in 2010. Dr. Thomas Roser of BNL succeeded Stephen Holmes of FNAL as the chair. Following the presentations by the accelerator members of J-PARC, enthusiastic and frank discussions were made, in particular, towards a steady and fast realization of 1 MW at RCS and 0.75 MW at MR fast extraction. The importance of a comprehensive scheduling was also pointed out because the common use of both MLF and MR must proceed with an approval of machine time for users consistent with the construction and the beam commissioning of the LINAC energy upgrade to 400 MeV.

Neutron International Advisory Committee (NIAC).

The NIAC was newly organized in fiscal year 2009 and held on February 24 to 26 in 2010, in which Dr. Dan Neumann (National Institute of Standards and Technology, US) is acting the chair. Previously this was a technical advisory committee for the neutron target technology and engineering and has been organized seven times since fiscal year 2002. Because Materials and Life Science Experimental Facility has started the user program since 2008, the mission of the committee has been changed so that it gives advice on organization, operation, safety, instrumentation and target station.

8th Muon Science Advisory Committee (MuSAC-8)

The MuSAC-8 was held on March 11 and 12 in 2010. The committee (chair: Dr. E. Morenzoni from PSI) expressed congratulation to all the people involved at J-PARC MUSE for their many achievements since the first successful extraction of muon beam. The committee was pleased to hear about the successes of the muon user program, which include the first refereed journal publication from J-PARC by S. Takeshita, et al. The committee reinforced the support of the ultra slow muon beam line for µSR as a top priority, and acknowledged the progress that was made thus far in its design. The committee concluded that the highest priority should be to secure funding for fully developing this beam line, as it would promise to be a unique tool for novel experiments in nano-materials research. The committee expressed their conviction that this beam line would have great potential even at reduced power, and that it would attract users from around the globe, suggesting the importance to involve the condensed matter physics and materials science communities in this unique opportunity.

Radiation Safety Committee

The Radiation Safety Committee met twice in fiscal year 2009. The seventh meeting was held on June 2, 2009 to discuss the application of 3 GeV Rapid Cycling Synchrotron, Materials and Life Science Experimental Facility, Main Ring (MR), Nuclear and Particle Physics Facility (HD), and Neutrino Facility (NU). The main points were the enlargement of two secondary beam lines in HD: K1.8 and KL, and the beam-intensity upgrade in MR and NU. At next, the 8th meeting was held on December 15, 2009, at which the application of HD was discussed. The main point was the enlargement of two secondary beam lines in HD: K1.1BR and KL.
Dates for Committees

1) Steering Committee
   - May 1st, 2009 @Nuclear Science Research Institute, JAEA, Tokai, Ibaraki
   - June 30th, 2009 @Ibaraki Quantum Beam Research Center, Tokai, Ibaraki
   - September 29th, 2009 @Ibaraki Quantum Beam Research Center, Tokai, Ibaraki
   - December 24th, 2009 @ Ibaraki Quantum Beam Research Center, Tokai, Ibaraki

2) User Consultative Committee
   - October 28th, 2009 @Tokyo Office, JAEA

3) MLF Advisory Board
   - 7th Board: September 7th, 2009 @Tokyo Office, JAEA
   - 8th Board: March 17th, 2010 @Nuclear Science Research Institute, JAEA

4) Program Advisory Committee for Nuclear and Particle Physics Experiments at the J-PARC 50GeV Proton Synchrotron
   - 8th Committee: July 17th - 19th @Tsukuba campus, KEK
   - 9th Committee: January 15th - 17th @Tsukuba campus, KEK
Publications
Publications in Periodical Journals

A-001
Maekawa, F.
J-PARC 1MW pulsed spallation neutron source
*Activation Analysis*, vol. 25, p. 15 (2010)

A-002
Ogura, K. et al.
Proton-induced nuclear reactions using compact high-contrast high-intensity laser

A-003
Yamamoto, K. et al.
Estimation of secondary electron effect in the J-PARC rapid cycling synchrotron after first study

A-004
Nagamiya, S.
Appointed to President-Elect for the Physical Society
*Butsuri*, vol. 65, p. 69 (2010)

A-005
Nagamiya, S.
Coming up a new facility J-PARC
*Butsuri*, vol. 65, p. 108 (2010)

A-006
Onuki, T. et al.
Concurrent transformation of Ce(III) and formation of biogenic manganese oxides

A-007
Shen, G. et al.
Tuning of RF amplitude and phase for the drift tube linac in J-PARC

A-008
Kato, T. et al.
Cryogenic hydrogen system for a spallation neutron source in J-PARC

A-009
Nagamiya, S.
Multi-Purposed Facility - J-PARC

A-010
Ukon, S. et al.
Radiation resistant cable

A-011
Nagamiya, S.
Research Curiosity and Nobel Prize

A-012
Nagamiya, S.
Birth of J-PARC
*Hamon*, vol. 18, p. 7 (2008)

A-013
Tatsumoto, H.
Through development of the cryogenic hydrogen system for the spallation neutron source in J-PARC
*Hamon*, vol. 19, p. 4 (2009)

A-014
Maruyama, R.
Effect of roughness correlation on diffuse intensity in a neutron supermirror
*Hamon*, vol. 19, p. 9 (2009)

A-015
Takahashi, N.
Construction of a novel backscattering spectrometer DNA at J-PARC

A-016
Kajimoto, R. et al.
4D space access neutron spectrometer 4SEASONS (SIKI)
*Hamon*, vol. 20, p. 8 (2010)

A-017
Oikawa, K. et al.
Launch of NOBORU (BL10)
*Hamon*, vol. 20, p. 34 (2010)

A-018
Hattori, T. et al.
Design concept and the current construction state of J-PARC high-pressure neutron diffractometer PLANET
*Hamon*, vol. 20, p. 39 (2010)

A-019
Sasaki, S. et al.
W-values for Heavy Ions in Gases
(The 2009 IEEE Nuclear Science Symposium and Medical Imaging Conference)

A-020
Ohshita, H. et al.
Performance of a Neutron Beam Monitor with a GEM for the High-Intensity Total Diffractometer at J-PARC
(The 2009 IEEE Nuclear Science Symposium and Medical Imaging Conference)

A-021
Tatsumoto, H. et al.
Numerical analysis of forced convection heat transfer of subcooled liquid nitrogen
(20th International Conference on Magnet Technology (MT-20))

A-022
Ogitsu, T. et al.
Status of superconducting magnet system for the J-PARC neutrino beam line
(The 2008 Applied Superconductivity Conference)

A-023
Okamura, T. et al.
Test results of superconducting magnets for the J-PARC neutrino beam line
(The 2008 Applied Superconductivity Conference)

A-024
Sakasai, K. et al.
Detection of fast neutron by storage phosphors with low q-ray sensitivity
(2007 IEEE Nuclear Science Symposium and Medical Imaging Conference)

A-025
Nagamiya, S.
Positive and negative aspects in Science

A-026
Enomoto, S. et al.
New utilization and promotion of RI

A-027
Fujii, Y. et al.
Japan Proton Accelerator Research Complex (J-PARC); Materials and Life Science Facility

A-028
Oh, S. et al.
Effect of interfacial roughness correlation
on diffuse scattering intensity in a neutron supermirror

A-030
Kubo, J. et al.
Improvement of poly (vinyl alcohol) properties by the addition of magnesium nitrate

A-031
Nagamiya, S.
Moving toward an opening at J-PARC

A-032
Oyama, Y. et al.
Quantum beams open up the future, 3

A-033
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