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J-PARC Accelerator Status

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Abstract

Japan Proton Accelerator Research Complex (J-PARC) has started the beam delivery at 2009 to the experimental facilities which are the neutrino experimental facility (T2K), the hadron experimental facility and the material and life science facility (MLF). However J-PARC had two big troubles during last three years: First one was induced by the Great East Japan Earthquake happened in March 2011 and the second one was caused by the radioactive material leakage from hadron experimental facility in May 2013. The damage to the accelerators from both troubles has been fixed by the effort of members. As a result J-PARC has resumed the beam delivery to users. The achieved beam power for T2K is 240 kW which is one third of design value of 750 kW. In this report, the status of the accelerator operation of J-PARC is described. Furthermore it is also described the measurement of the extinction level for the physics experiment.

Keywords: Proton accelerator, Intensity frontier, T2K, Neutrino, COMET, Muon

1. Introduction to J-PARC

Japan Proton Accelerator Research Complex (J-PARC) constructed by the collaboration between KEK and Japan Atomic Energy Agency (JAEA) is a high-intensity proton accelerator facility. It is in the Tokai campus of JAEA by the Pacific Ocean as shown in shown in Fig. 1.

The construction of the J-PARC began at 2001 and it was completed at 2007. The first beam commissioning of the accelerators was carried out during the period from 2007 to 2009. From 2009 the beam delivery to users was started.

The accelerator of J-PARC consists of a 400 MeV linac, a 3 GeV rapid cycle synchrotron (RCS) and a 30 GeV main ring synchrotron (MR). J-PARC has three experimental facilities. These are the Material and Life science Facility (MLF), Neutrino experimental facility (T2K) and Hadron experimental facility, respectively. Furthermore J-PARC has started the design of the test facility for the accelerator-driven transmutation system.

J-PARC began the beam extraction to the neutrino experiment (T2K) and the hadron experiments at 2009. However J-PARC had two big troubles during last three years. First one is the Great East Japan Earthquake happened in March, 2011. It was required 9 months to fix the damage by the earthquake. The second one is the incident of the radioactive material leakage from the hadron experimental facility in May 2013. Damages and causes of the incident has been fixed by the reconstruction of system of J-PARC center except for the Hadron experimental facility. Therefore J-PARC was able to resume the beam delivery to T2K and MLF. Hadron facility is required to redesign the facility includes the beam target. Thus the restart of experiments may be in February 2015 at the soonest.

The achieved beam power for T2K is 240 kW which is one third of design value of 750 kW. Just before the incident, the beam power for the hadron experiments was 25 kW which is one fourth of design power of 100 kW.

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Figure 1: A complete view of J-PARC. Upper part of the photo is the Pacific Ocean. Linac and RCS are in left side of the photo. There are MR and three experimental facilities in the right side.

2. Facilities

As mentioned in the introduction, J-PARC has three facilities. The outline of them are described in the following sections.

2.1. Material and Life science Facility (MLF)

MLF shown in Fig. /refMLF supplies users with the strong neutron and muon beam which are made by the intense 3 GeV proton beam from the RCS. MLF has 21 neutron beam lines and four muon beam lines. The target for the muon production is located in the upper stream of the neutron production mercury target.

The beam power on MLF target is 300 kW for the practical operation at present time. The achieved power in RCS in the beam study is approximately 0.6 MW which is just 60 % of the design beam power of 1 MW. However the beam study to achieve the 1 MW on MLF target will be started because the linac beam energy and beam current has been upgraded.

Figure 2: Material and Life science Facility (MLF).

2.2. Neutrino experimental facility

The neutrino beam is produced by the intense 30 GeV proton beam extracted from MR. The extraction beam line for the neutrino target is located inside of the ring. Thus it requires the stronger magnetic field so that the neutrino beam line uses the superconducting combined magnet shown in Fig. 3.

Figure 3: The neutrino beam line.
Blue tanks have superconducting magnets.

2.3. Hadron experimental facility

The main experiments in the hadron facility are nuclear physics with kaon. Recently the electron-muon conversion experiment called COMET[7] has been approved. Therefore the new beam line for the COMET is being constructed. Unfortunately the incident of the radioactive material leakage upset the schedule of the experiment in the hadron facility. For the prevention of recurrence of the incident, the facility shown in Fig. 4 is being reconstructed. In particular, the airtightness of