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Status of J-PARC project

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A B S T R A C T

The Japan Proton Accelerator Research Complex (J-PARC) has progressed extensively in the last few years. Successful commissioning of the first stage accelerator linac started on November of 2006, in October of 2007; the 3 GeV synchrotron also successfully accelerated protons up to 3 GeV with 5 kW beam power by a single shot. Following these successes, the first neutron beam was observed from the spallation neutron source at Material and Life Science Facility on May of 2008.

1. Introduction

The J-PARC (Japan Proton Accelerator Research Complex) construction project team was organized by the two institutes, Japan Atomic Energy Agency (JAEA) and High Energy Accelerator Research Institute (KEK), after the Neutron Science and Japan Hadron Facility Projects promoted by each institute were integrated in 1998. The construction of the J-PARC facility was started at the Tokai site of JAEA in 2001 and continues toward completion at the end of March, 2009.

J-PARC is a high intensity proton accelerator facility consisting of three accelerators: a linac, a 3 GeV synchrotron and a 50 GeV synchrotron. Their goals for beam powers are 1 MW. The purpose of the accelerators is to provide high intensity secondary particle beams produced by proton induced nuclear spallation reaction, and by using particles such as pion, muon, neutrino and neutrons to promote a variety of sciences from fundamental physics to applied physic and engineering. The particle research facilities constructed at J-PARC are the Materials and Life Science Facility (MLF) for usage of muon and neutron beams, and the Nuclear and Particle Physics Facility (Hadron Facility) for K-meson (Kaon) beam and Neutrino Facility for neutrino beam [1–5].

The facilities will start the user operations between December 2008 and April 2009. The construction project will be completed by April 2009, after which J-PARC will move a phase to its operation.

2. Status of facility construction

J-PARC building construction has almost been completed by the end of December 2008 except for the neutrino facility. The nuclear transmutation facility was postponed to the second phase program by the review committee before start of the project, so that facility remains a plan. Construction progress followed the schedule as shown in Fig. 1 without change since 2006. All components of the accelerators were installed and moved to commissioning phase at the current time. Photos of three installed accelerators are shown in Fig. 2. However, the linac whose specification was 400 MeV in original plan is currently installed to only 181 MeV capability. This is because the original design of 3 GeV synchrotron was changed in 2003 due to expand the ring size to avoid beam losses as predicted by a new beam simulation study. This choice was traded off against the linac specification to keep costs within budget. Completion of the linac to 400 MeV acceleration was postponed until after start of user operations at that time.

Some experimental devices in the research facilities have also been installed at this time for the first experiments. Especially in the MLF, 14 neutron beam line instruments were under constructions as shown in Fig. 3. Seven of those will start the operation at the end of December 2008, so that a selection process of the experimental proposals has also been started. Tow of the instruments belongs to the local government (Ibaraki Prefecture) which are managed to promote an industrial use of neutron facility. One muon beam line is also under preparation for operation in December 2008 in the MLF.

In the Hadron facility, a huge 750 kW proton beam dump was assembled by copper, iron and concrete blocks, and one Kaon beam line branch is under installation for a day-one experiment which will use 1.8 GeV Kaon beam. The neutrino facility is still in building construction phase.

3. Progress of beam commissioning

Proton beam commissioning of accelerators began with the linac in October 2006 and acceleration to 181 MeV was achieved in January 2007. The beam commissioning of the 3 GeV synchrotron was started on October 2007, and succeeded with beam injection, acceleration and extraction. By September 2008, the peak acceleration beam power (the number of protons in a pulse) has

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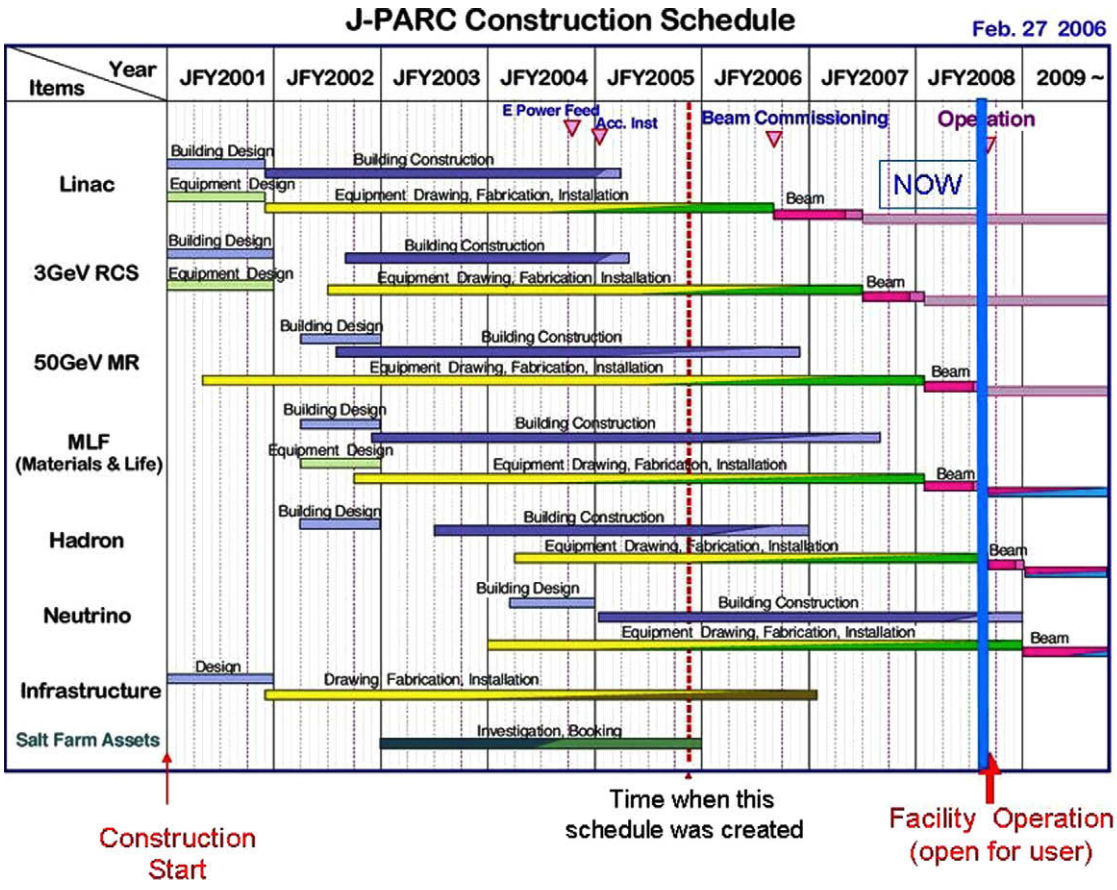

Fig. 1. J-PARC construction schedule.

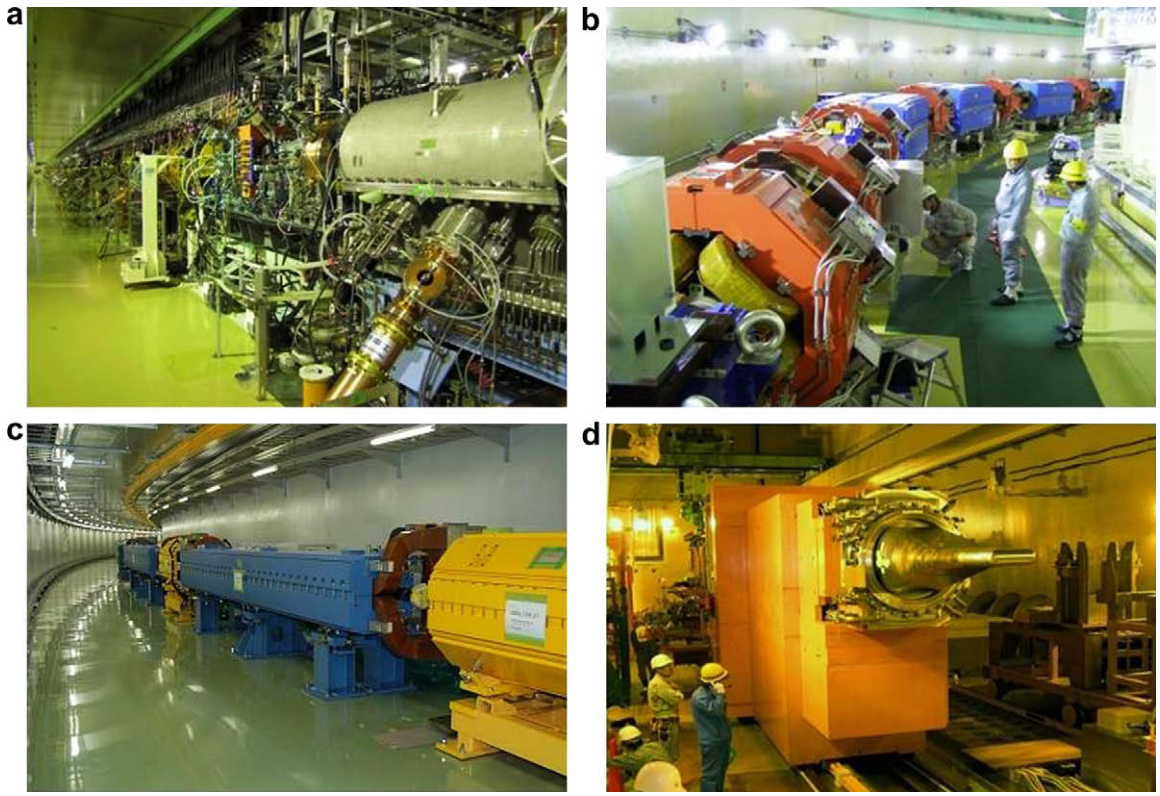

Fig. 2. Accelerators and mercury target in MLF. (a) Linac, (b) 3 GeV synchrotron, (c) 50 GeV synchrotron, and (d) mercury target assembly in MLF.

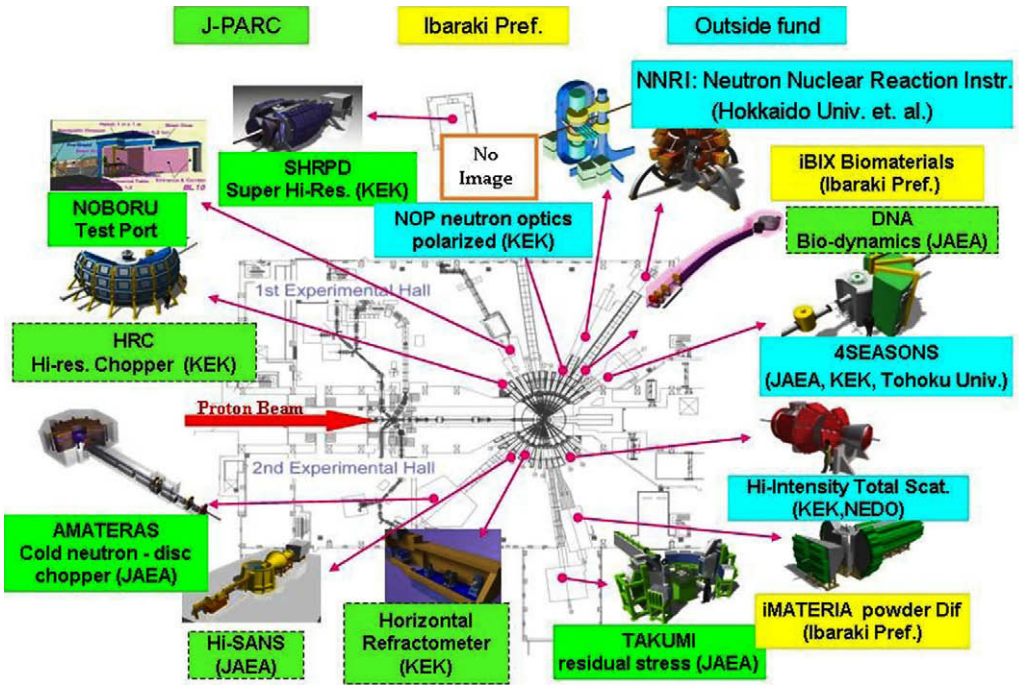

Fig. 3. Neutron instruments under preparation for the day-one experiments.

achieved to 315 kW equivalent to that for 25 Hz in normal operation. So far the operation of 210 kW–25 Hz was proved in 70 s, although the acceleration was stopped due to permission limit of step by step licensing. However, this is already 1/5 of the goal power. As for the 50 GeV synchrotron, beam injection from the 3 GeV synchrotron and the circulation at 3 GeV were achieved on May 2008.

As for the research facility commissioning, a 3 GeV proton beam was introduced onto the mercury target (Fig. 2d) in the MLF neutron source on May 2008, and the neutron spectrum from the target was observed for the first single shot pulse. The neutron flight time spectrum shown in Fig. 4 was obtained by the current mode TOF system which was recorded the Li-glass detector current in time. The observed spectrum showed a good agreement with the design calculation. At the same time, several instruments were tested by neutron beam, and their data also showed a good performance of the pulse structure, for example, the super high resolution powder diffract-meter gave the best spatial resolution in the world with the decoupled moderator [4].

The muon target and the muon beam channel have tested, and the first muon spin rotation signal was obtained on September 2008.

4. Future plan

To reach 1 MW beam power from the 3 GeV synchrotron, the linac energy of 400 MeV is vital because the injection beam current to the synchrotron is dominated by the injection energy. This is an urgent issue to achieve the final power goal, so that the additional project to construct 400 MeV linac has started in 2008 for the coming 3 years.

Second, experimental suites for the research facilities should be fully equipped for user demands, including muon and neutron beam instruments and hadron beam channels, some of these were partly deferred to the phase II program.

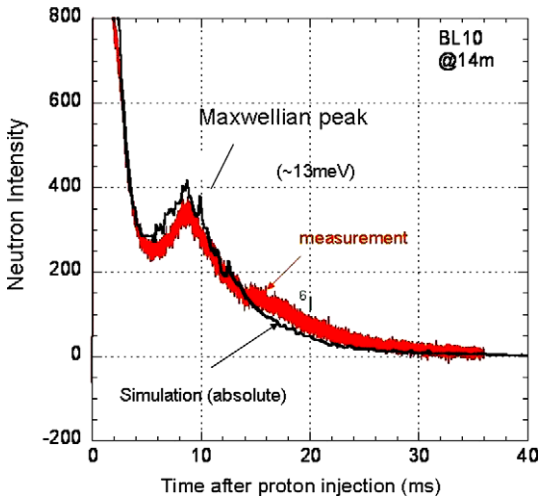

Fig. 4. Neutron flight time spectrum obtained by the first shot of beam on the mercury target.

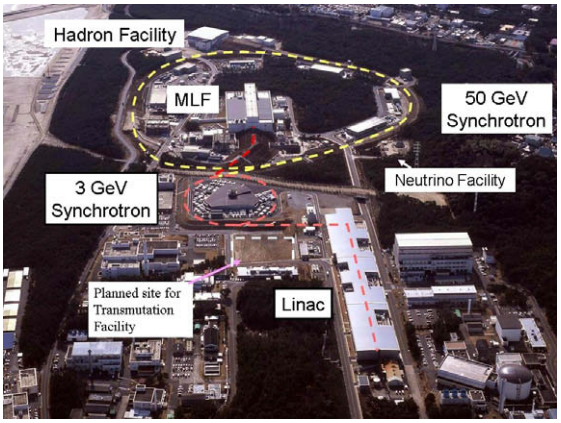

Fig. 5. Photo of the present J-PARC facility site and the proposed site for transmutation facility.

The transmutation facility had been completely separated to the phase II construction project should now be promoted at the proposed site shown in Fig. 5. The transmutation facility was parte of the original JAEA project supporting nuclear energy field. The governmental review was started on September 2008 under the Atomic Energy Commission to include this part into the J-PARC.

5. Concluding remarks

J-PARC facility construction has almost been completed by December 2008 except for the neutrino related facilities. The beam commissioning for accelerators has very successfully progressed and the obtained beam power was reached 20% of the power goal. The Materials and Life Science Facility (MLF) started the beam commissioning, and the neutron and the muon target systems were successfully operated. The neutron source characteristics data by the first on-beam test showed very good agreement with the design. The whole facility will fully move to the user operation phase in 2009 while the accelerator beam studies and new construction project will continue for several years toward the final goal of 1 MW beam power at 3 GeV proton beam.

Acknowledgements

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