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Construction status of the J-PARC project

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Abstract

From Japanese fiscal year JFY2001, which started on April 1, 2001, a new accelerator project to provide high-intensity proton beams proceeded into its construction phase. This project, which is now called the J-PARC (Japan Proton Accelerator Research Complex) project, is in progress under a cooperation of two institutes, KEK and JAERI. We set a goal to achieve 1 MW proton beams at 3 GeV and 0.75 MW beams at 50 GeV. The construction period is 7 years, with anticipated first beams in the spring of 2008 In this article I will describe the project itself and the present status of the project.

1. What is J-PARC?

In the fall of 1998 two institutions, KEK (National High Energy Accelerator Organization) and JAERI (Japan Atomic Energy Research Institute) started their joint effort to propose one high-intensity proton accelerator complex with a MW class beam power. This action was motivated by a suggestion from the Government, since both institutions were then proposing accelerator projects with a common goal to attain high-power proton beams.

The present project has the following components:

- 400 MeV proton Linac (normal conducting) to inject beams to 3 GeV proton synchrotron.
- A superconducting Linac to accelerate protons from 400 MeV to 600 MeV. The 600 MeV proton beams will be used for R&D toward nuclear transmutation.
- 25 MHz 3 GeV proton synchrotron with 1 MW power. This will be used primarily for materials and life science research with neutrons and muons.
- 50 GeV proton synchrotron with slow extraction for kaon beams etc. and fast extraction for neutrino beams toward Super Kamiokande, a neutrino detector located at 295 km west of J-PARC.

The accelerator complex will be constructed at the JAERI Tokai site. Since the entire cost of the project is about 189 billion yen, the Government suggested to split the project into two phases: The Phase 1 budget, which amounts to 135 billion yen, was officially approved from JFY2001, whereas the remaining Phase 2 budget had to wait for another process for approval. A part of Phase 2 programs, the neutrino experiment, has been approved to start from JFY2004. The current Phase 1 budget is 151 billion yen (see Fig. 1).

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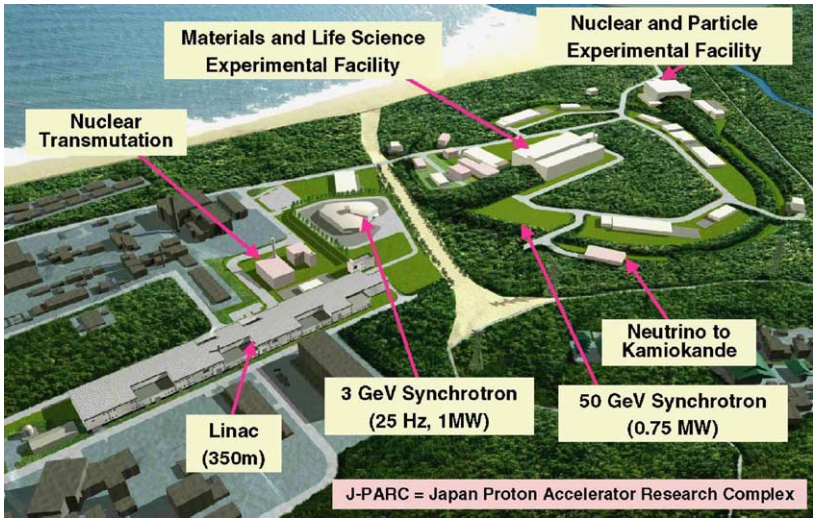

Fig. 1. Layout of the J-PARC project at the JAERI-Tokai site.

2. Accelerators and facility construction

The accelerator construction is in progress at a reasonable speed. Already, a H^- ion source was constructed with a satisfactory performance to allow a peak current of Linac greater than 50 mA. The radio frequency quadrupole (RFQ) accelerator and the initial stage drift tube Linac (DTL) have also been completed. At the end of October, 2003, the first test run for the DTL (the first 20 MeV portion) was made at KEK. On the first day of testing, 6 mA was successfully accelerated and, in a week later, the acceleration of 30 mA was achieved. The DTL is shown in Fig. 2.

In Japan the major elements will be fabricated at commercial companies. Contracts with companies have been completed at the level of 80% for the entire accelerator elements.

For the facility construction, the ground breaking ceremony was held in June, 2002. Subsequently, construction work was started at a rapid speed. Excavation for building construction is underway in many places at the Tokai site of JAERI. A view from the sky is shown in Fig. 3.

Very recently, ancient salt farms were discovered on the construction site of the 50 GeV synchrotron. As a result, archeological studies must be done. This discovery,

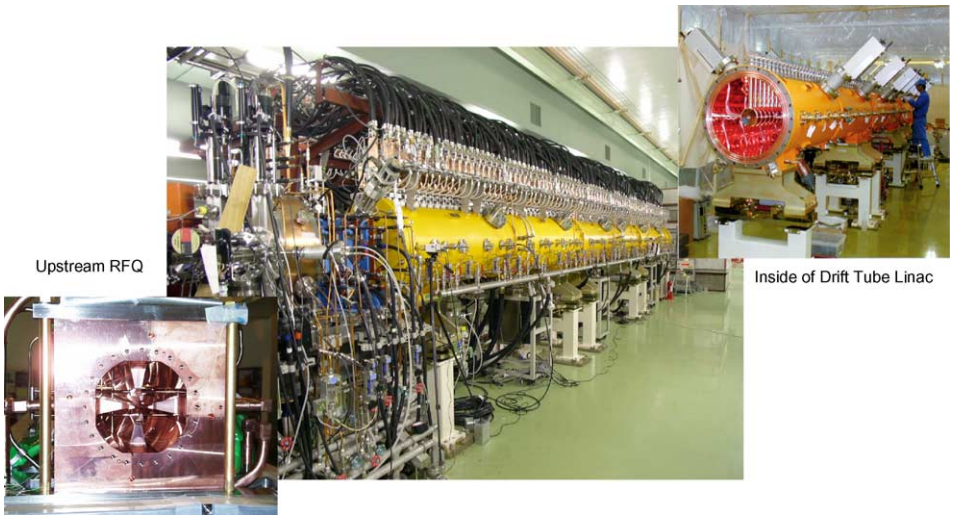

Fig. 2. Drift Tube Linac (DTL). Acceleration up to 30 mA peak current was achieved at 20 MeV.

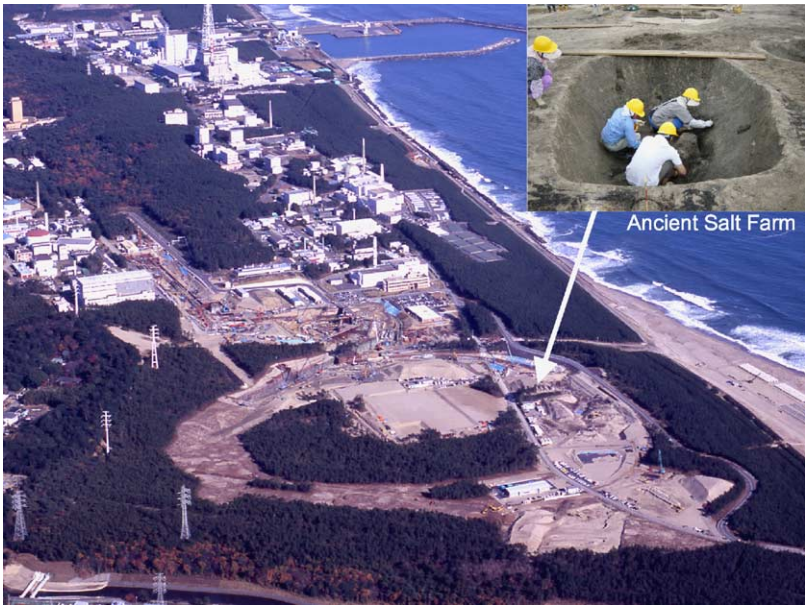

Fig. 3. View from the sky of the construction area.

thus, induces a certain delay in the construction schedule. The project team is making every effort to minimize the delay. The current estimate of the delay would be about half a year. As described below, the entire construction schedule is now 7 years instead of the originally scheduled 6 years, due to the budget constraint. The slower funding profile affects a delay more than that induced by this archeological study.

Figs. 4 and 5 show the progress in the Linac area and the 3 GeV synchrotron area, respectively. A rapid

Fig. 4. Progress in the Linac area.

Fig. 5. Progress in the 3 GeV area.

progress for construction is observed during the year of 2003.

3. Budget and schedule

A highlight in the summer, 2003, in the budget negotiation for JFY2004 was to choose either (a) a neutrino program from JFY2004 or (b) an immediate funding for the energy recovery of Linac before the completion of the Phase 1 project of J-PARC. Note that, within the present budget constraint, the Linac energy can go up to 200 MeV only, due to several design changes and the associated cost increase. Thus, in order to construct 200–400 MeV Linac, additional funding is required. The requests (a) and (b) are, thus, mutually conflicting in budget.

The project team selected item (a) as the first choice for the JFY2004 budget by shifting item (b) to a later year (say, after the completion of the 200 MeV Linac). The reason is illustrated in Fig. 6. With the 400 MeV Linac, the full power from the 3 GeV synchrotron would be 1 MW, and an expected power rise as a function of the year would look like the dashed curve shown in Fig. 6. On the other hand, with a 200 MeV Linac the expected power from 3 GeV is smaller than the dashed curve by a factor of 0.6, since the full power in this configuration would be 0.6 MW. The expected power rise in this case is shown by the solid curve in Fig. 6. If a 200–400 MeV Linac is installed during JFY2008-2010, immediately after the completion of the 200 MeV Linac, then, the difference between the dashed and solid curve is almost negligible.

In the summer of 2003 the MEXT, the funding agency for the J-PARC project, agreed with the above proposal from the project team. On the other hand, another review conducted in October, 2003 by the Council of Science and Technology Policy (CSTP) recommended (b) as the first choice and (a) as the second. Namely, this CSTP ranked the neutrino program low. Facing the conflict between MEXT and CSTP, a third review panel was formed in November, 2003. Finally, the original scenario proposed by the project team was adopted by this panel and, subsequently, the Ministry of Finance of the Japanese Government approved the neutrino program from JFY2004 (see Fig. 7).

Local governments, both Ibaraki Prefecture and Tokai Village, have been contributing actively to our project. Recently, the Ibaraki Prefecture decided to construct a few beam lines for neutron scattering studies at J-PARC.

Currently, over 300 people from JAERI and KEK are working for the project and striving for the successful completion of the construction in 2007.

The current project schedule is shown in Fig. 8. The goal is to complete the project at the end of JFY2007. At

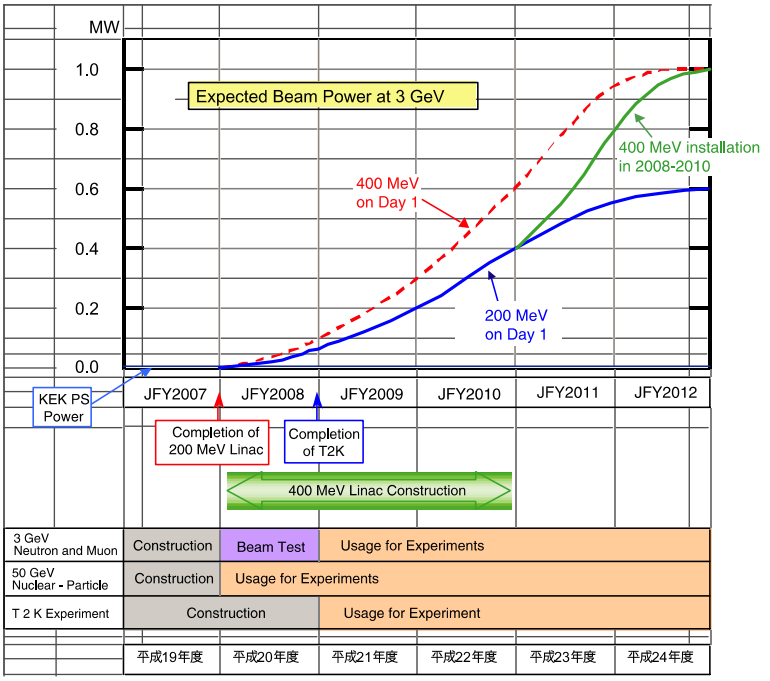

Fig. 6. Expected power from the 3 GeV synchrotron.

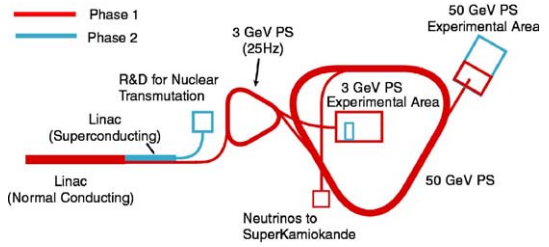

Fig. 7. Phase 1 and Phase 2 in the J-PARC project.

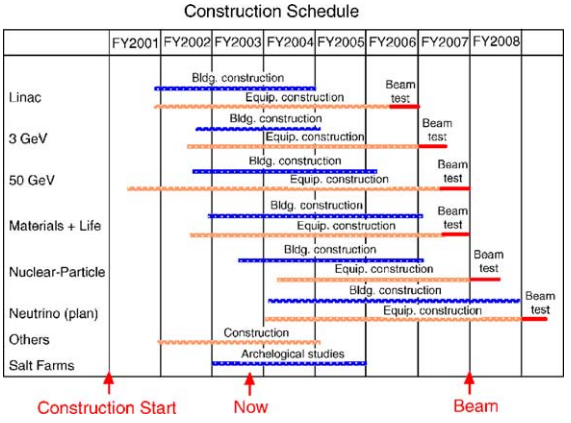

Fig. 8. Construction schedule of J-PARC.

that point an expected beam power would be about 1% of the full power. It will take a year before reaching the level of 10% of full power.

4. User facilities and experiments

We plan to open the facility to general neutron users when the beam power reaches at 10% level of the maximum beam power. An anticipated usage for neutron users will, thus, start in the spring of 2009, whereas the usage for the 50 GeV beam line by experimental groups will start in the spring of 2008.

In 2002, the Project Office called for Letters of Intent for (a) neutron scattering experiments at 3 GeV and (b) nuclear/particle physics experiments at 50 GeV. Concerning the neutron proposals, 18 LoI's were submitted to the Project Office. The Neutron Equipment Committee recommended about half to move to the next stage. Detailed examinations of these proposals are currently in review of this Committee. Every year, the call for Letters of Intent is planned until 25 beam lines are occupied.

In regard to neutron experiments, a new research group called the Neutron Science Research Center was officially created at JAERI in 2003. This research group contains eight groups. Recently, a new funding for the equipment design was approved at this new Center.

Concerning nuclear/particle physics experiments, 30 LoI's were received at the Project Office (about 500

physicists, 1/3 from Japan and the rest from the US, Europe and Asian countries). The Nuclear and Particle Physics Committee evaluated all LoI's and recommended the neutrino proposal for the fast extracted beamline and two Day-1 experiments for the slow-extracted beamline. Also, they recommended a strategy of how to proceed other proposed experiments at 50 GeV. Additional LoI's for 50 GeV may also be accepted in the future.