

J-PARC CONSTRUCTION AND ITS LINAC COMMISSIONING

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Abstract

The J-PARC (Japan Proton Accelerator Research Complex) is under construction in JAERI Tokai site. The beam commissioning will start there by the end of 2006. Prior to this, the front end of the linac was beam-commissioned in 2003 at KEK. The negative hydrogen beam with a peak current of 30 mA was accelerated up to 20 MeV by the first tank of the three DTL's following the 3-MeV RFQ linac. The 324-MHz DTL contains the electro quadrupole magnets with water-cooling channels specially fabricated by means of electroforming and wire-cutting technologies. The construction status of the J-PARC accelerator is also presented.

INTRODUCTION

The low-energy front of the J-PARC linac was beam-commissioned up to 20 MeV (the first cavity among the three DTL cavities) in November, 2003, when the full peak beam current of 30 mA was already accelerated.

Phase I of the J-PARC (Japan Proton Accelerator Research Complex) project included the 400-MeV proton linac, the 3-GeV, 1-MW rapid-cycling synchrotron (RCS) and 50-GeV main synchrotron (MR) [1-7]. In Phase I, however, the MR will be operated up to 40 GeV, since the fly-wheel electric power system will be ready only in Phase II. The superconducting proton linac to accelerate the 400-MeV proton beam to 600 MeV, the Accelerator-Driven Nuclear Waste Transmutation System (ADS) Experimental Facility, and the Neutrino Facility were also planned in Phase II. The Materials and Life Science Facility (MLF) in Phase I is equipped with a full-power neutron production target (muon production target as well) in a full-size building, while Phase I building for Nuclear and Particle Physics Experimental Facility (NPF) is of half size. The remaining half of the building will be added in Phase II.

Phase I started in April, 2001, to complete in March, 2007. The construction of both the accelerator facility and the civil engineering had been in general on schedule until last year. The expected bird view shown in Fig. 1 is compared with the Fig. 2 photographed in the end of last year.

Last year some changes were made for the J-PARC project. The detail and the influence on the beam performance is presented in the next section. The construction status of the J-PARC accelerator is reported together with some development results and the linac beam commissioning in the following sections.



Figure 1: The expected bird view of the J-PARC.



Figure 2: The present photograph of the J-PARC.

UPDATED SCHEDULE

The following three major changes came into the project. First, the Neutrino Facility was approved for the construction starting from April 2004 to complete in March 2009, implying that the Neutrino Facility was forwarded from Phase II to Phase I. The 40-GeV proton beam (ultimately 50-GeV beam) fast extracted from the MR will be used for the production of the neutrinos which will be sent to the detector SUPERKAMIOKANDE located at the distance of 300 km from the J-PARC facility.

Second, the linac energy was decreased from 400 MeV to 180 MeV in order to compensate the budget overflow in the linac and RCS. Although the RCS beam power is reduced from 1 MW to 0.6 MW by this, the MR beam power may be kept as original by increasing the injection

time from the RCS to the MR. The present building can accommodate the 400-MeV linac, and the energy recovery to 400 MeV will be submitted to the funding agency immediately after the completion of Phase I.

Third, the funding to the linac and the RCS was delayed by one year. The schedule for the MR building had been delayed by more than one year for the archaeological investigation of the ancient salt pans. However, the delay in the beam commissioning schedule was managed to decrease to half a year. The updated construction schedule is shown in Fig. 3.

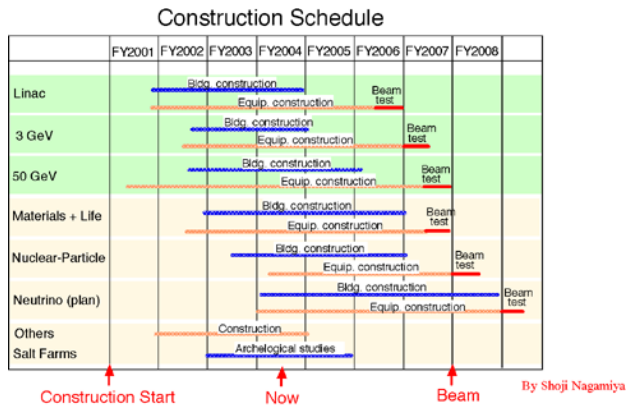


Figure 3: The J-PARC construction schedule updated, where FY stands for Japanese Fiscal year starting April.

ACCELERATOR STATUS

Most of the accelerator components were ordered by the end of March 2003. All the linac accelerating structures will be completed by this fall. The installation of the linac, RCS and MR accelerator components will start in April, 2005. The linac beam commissioning at the Tokai site will start in fall, 2006.

Recently the first RCS quadrupole magnet was completed as shown in Fig. 4. Special devices, such as stranded coils, Rogowsky-like cuts, and the slits at the core ends are incorporated in order to reduce the eddy-current effects on the magnets.[8]



Figure 4: The RCS Q magnet first produced

Two thirds of the bending magnets (BM's) and one third of the quadrupole magnets (QM's) for the MR are completed as scheduled, while the field measurements of BM's and QM's are in progress.

The RF accelerating system based on the cavities loaded with the magnetic alloy (MA) is made use of for both the RCS and MR. [9] The two cut cores are separated by only 1 mm in order to adjust its Q value to the optimum value of 2. The precise machining of the fragile cut cores made of the resin-impregnated MA tapes was only possible by a water-jet technique. The high-power test of the system is under way. [10]

LINAC BEAM COMMISSIONING

The beam study of the linac low-energy front has been in progress in the KEK site since 2002. The beam study result of the Medium Energy Beam Transport (MEBT) was reported in Ref. [11], where the beam chopper [12] was in operation with the rise and falling times of 15 ns.

Last November, the first H⁺ beam was accelerated by the first tank of Drift-Tube Linac (DTL) up to 20 MeV (Fig. 5). The accelerated peak current of 30 mA was already sufficient for the first goal of 0.6 MW at the extraction of the RCS to the MLF.

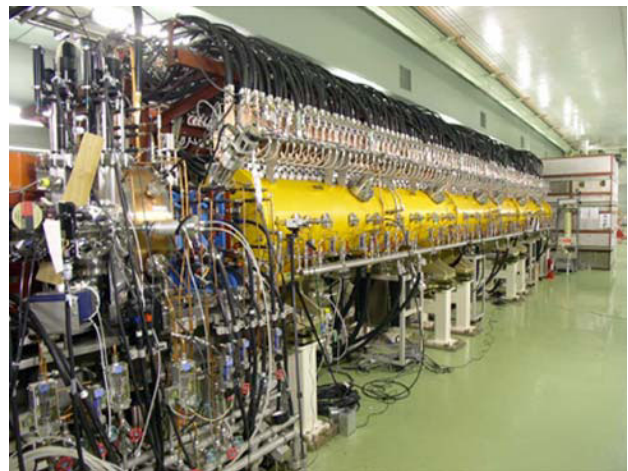


Figure 5: The first tank of DTL.

CONCLUSION

The construction of the J-PARC Phase I is under way for the first 3-GeV beam to the MLF in fall, 2007 and for the first MR beam to be extracted to the NPF in March, 2008. Now, Phase I includes the neutrino facility to send the neutrino beam to the SUPERKAMIOKANDE in 2009.

The beam power of the RCS in Phase I is reduced to 0.6 MW, since the linac energy is reduced to 180 MeV. It is planned that the linac energy recovery to 400 MeV will start immediately after the completion of Phase I. The MR beam power will not be affected by the linac energy reduction, if the beams from the RCS to the MR can be injected as long as 0.6 ms.

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