Poster presented at the 12th International Conference on Muon Spin Rotation,Relaxation and Resonance (μSR 2011), May 16-20, 2011, Cancun, Mexico.

New Muon Kicker System for the Decay Muon Beamline at J-PARC

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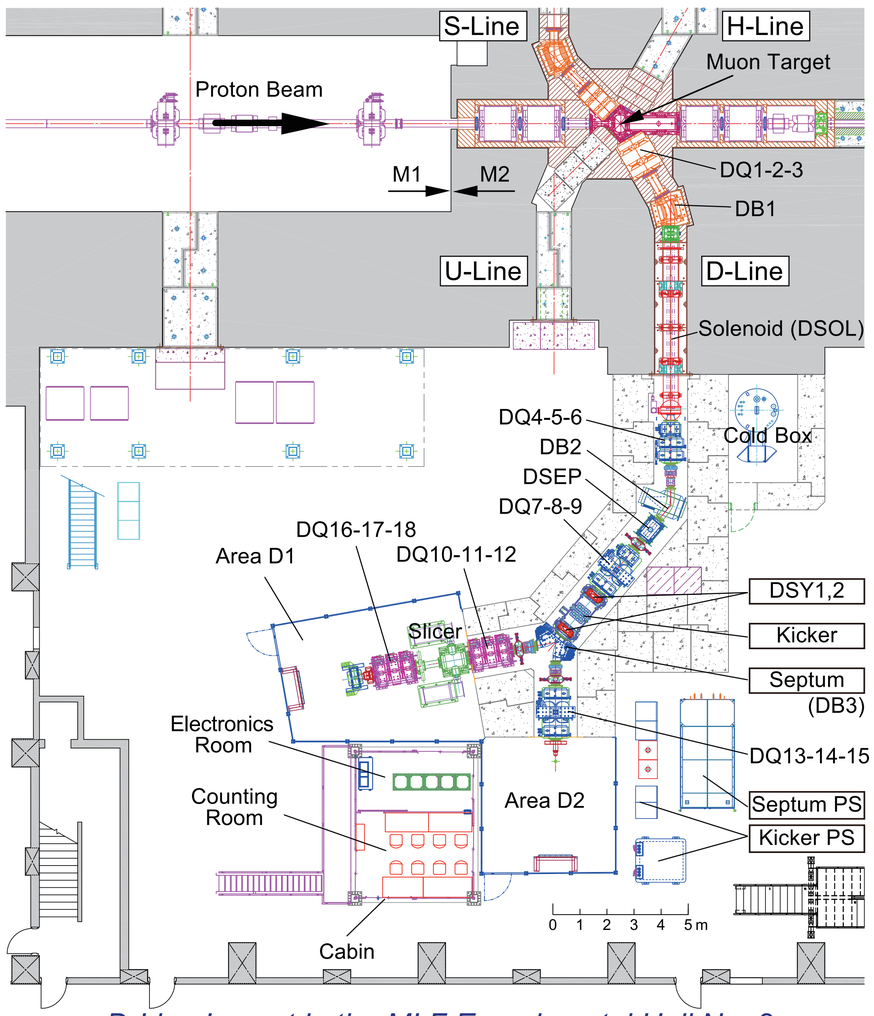


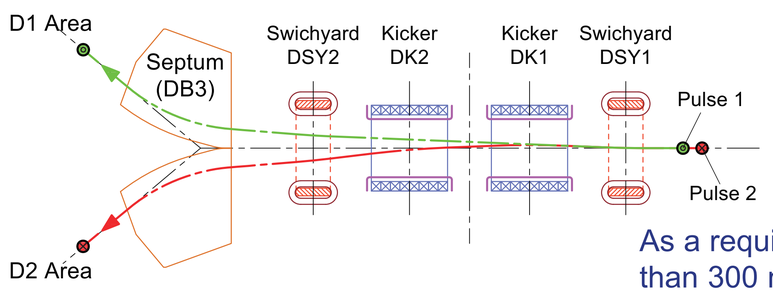
D-Line Layout in the MLF Experimental Hall No. 2

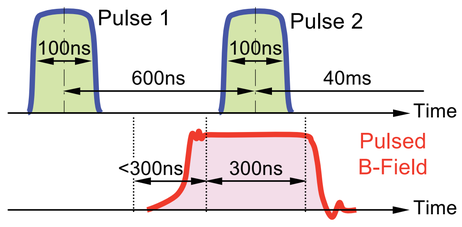
Introduction

At J-PARC Muon Science Facility a conventional superconducting decay muon beamline (D-Line) was constructed that can extract surface μ^+ and decay μ^+/μ^- up to 120 MeV/c. This beamline will be used for various kinds of muon experiments like μSR, muon catalyzed fusion and nondestructive elements analysis.
Similarly to the ISIS facility at RAL, the muon beam produced at J-PARC has a double-pulsed structure of 100 ns wide, separated by 600 ns with a repetition rate of 25 Hz. To utilize the muon beam more efficiently, a muon kicker system will be installed to separate the double-pulsed beam and send the two pulses to two experimental areas simultaneously, allowing μSR experiments with single-pulsed muons. A new muon kicker system (whose design was based on the magnetic kicker at RIKEN-RAL Muon Facility) is now been constructed. New state-of-the-art power supplies are also been fabricated. The installation in the beamline is planned in summer 2011.

Muon Kicker System

The muon kicker system is designed to separate and transport single-pulsed muon beam up to 60 MeV/c to both experimental areas simultaneously, and double-pulsed muon beam up to 120 MeV/c to either experimental area D1 or D2. The two switchyard magnets DSY1 and DSY2 deflect the muon beam to the right by 4.5° (2.25°/switchyard) so that the beam is shifted by 100 mm at the entrance of the septum magnet leading to the area D1. Then, the two kicker magnets DK1 and DK2 deflect the second muon pulse in the opposite direction by 9° (4.5°/kicker) so that it enters the septum magnet on the left leading to the area D2.



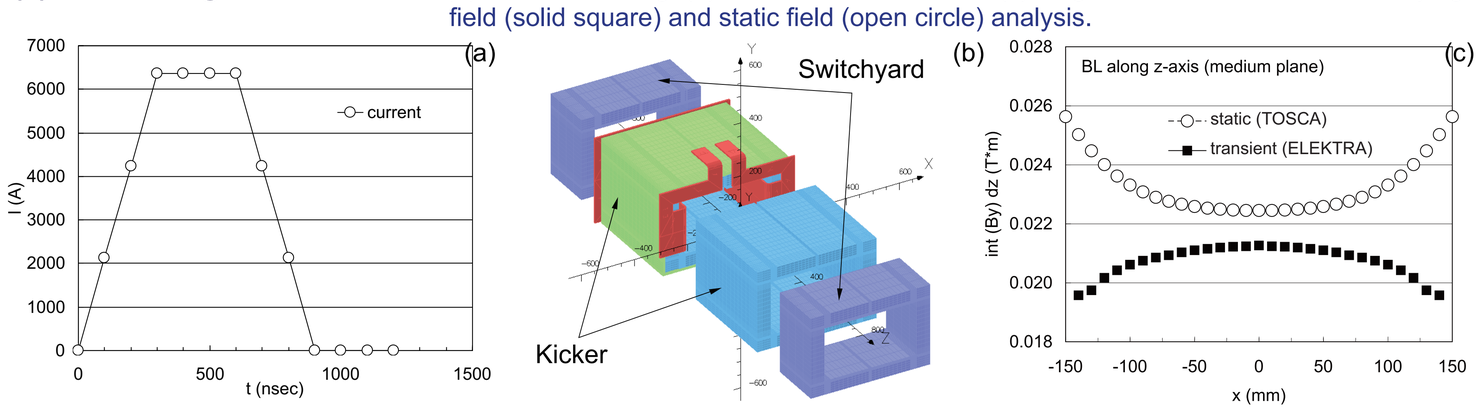


As a requirement, the kicker timing should have a rise-time of less than 300 ns, and a flat top (±3%) of 300 ns. The decay time is not critical since the following muon pulse comes only after 40 ms.

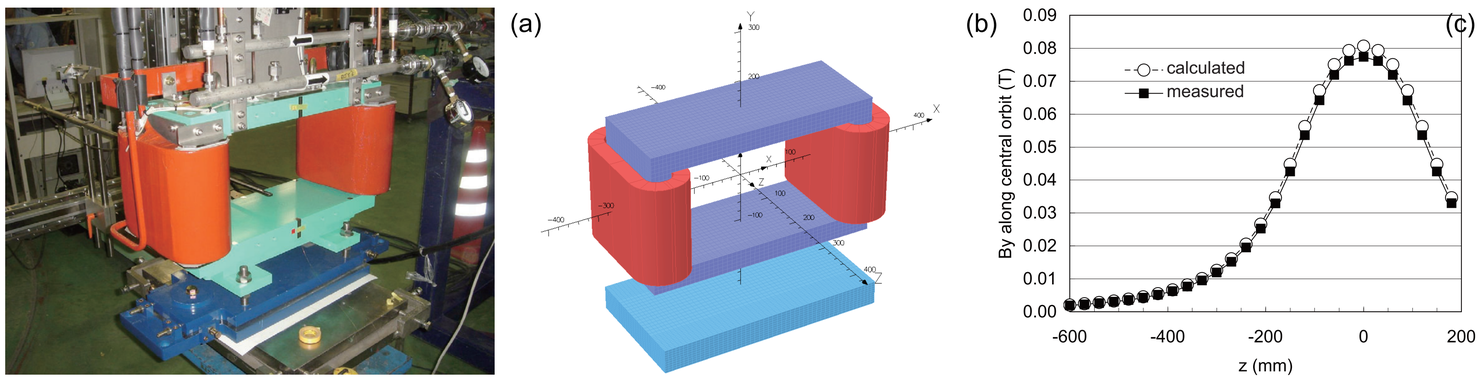
Magnetic Field Evaluation

The kicker magnet simulation was performed using the code OPERA-3D (ELEKTRA) for the time varying magnetic field analysis. The magnetic field distribution is different from that of the static field analysis due to the generation of eddy currents, etc. The magnetic field evaluation of the septum and the switchyard magnets were performed using the code OPERA-3D (TOSCA) for static field analysis.

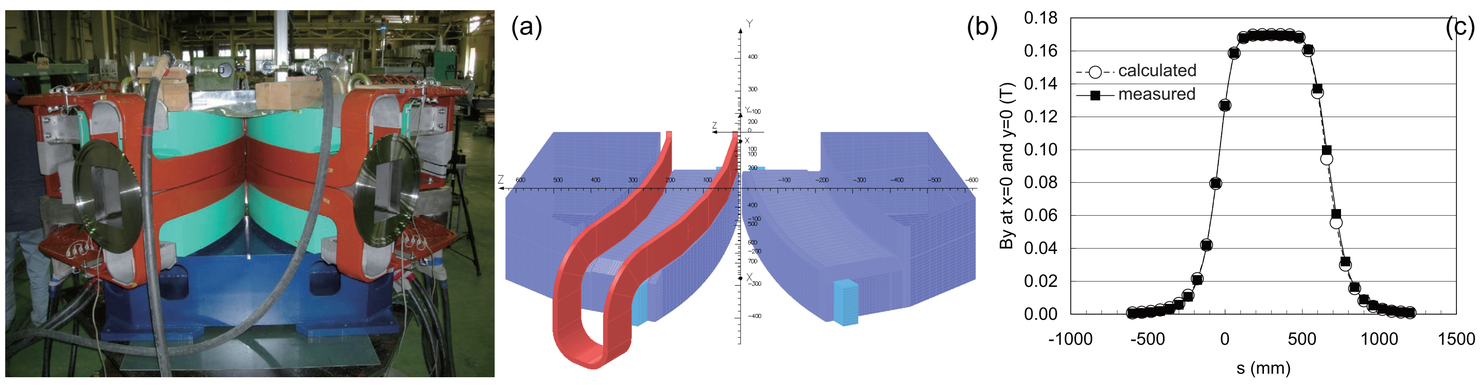
(1) Kicker Magnet Simulation: (a) excitation timing, (b) OPERA-3D model, and (c) magnetic field results for time varying field (solid square) and static field (open circle) analysis.



(2) Switchyard Magnet: (a) fabricated magnet, (b) OPERA-3D model, and (c) magnetic field distribution results.

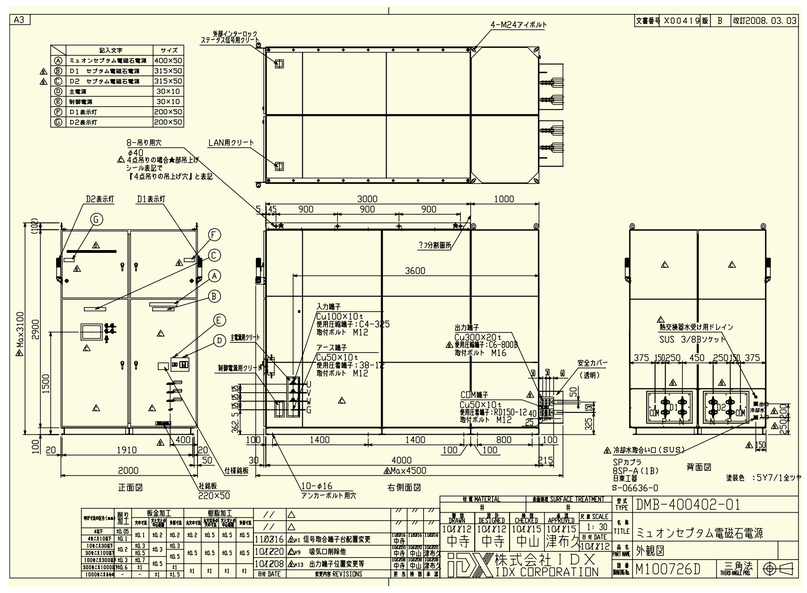


(3) Septum Magnet: (a) fabricated magnet, (b) OPERA-3D model, and (c) magnetic field distribution results.



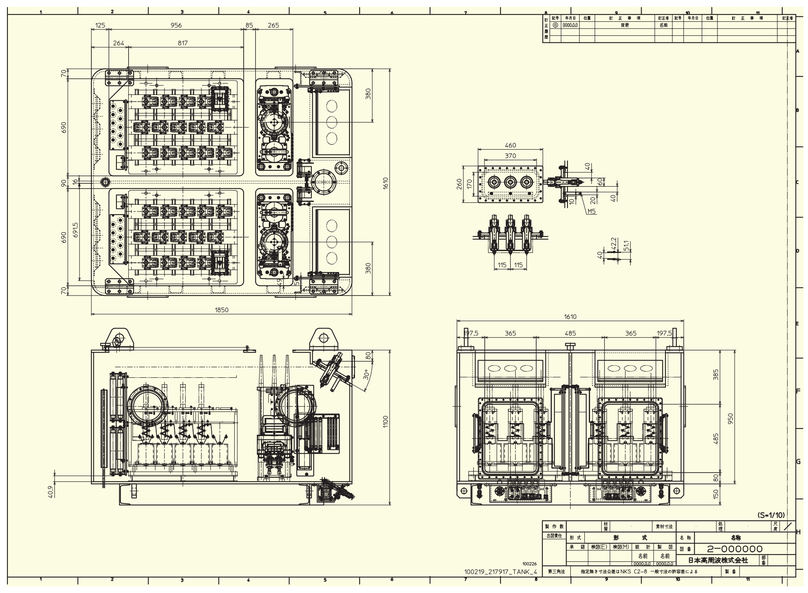
Septum Power Supply

A solid-state power supply has been designed and developed to provide high quality performance and stability (ripples 2 x 10^{-5} rms) considering symmetry in the logic and digital feedbacks. It can generate independently twice 2000A/40V for the septum mode and combined 4000A/40V for the bending mode. The completion is scheduled in June 2011 with an actual loading test using the septum magnet at the company (IDX Co. Ltd.).

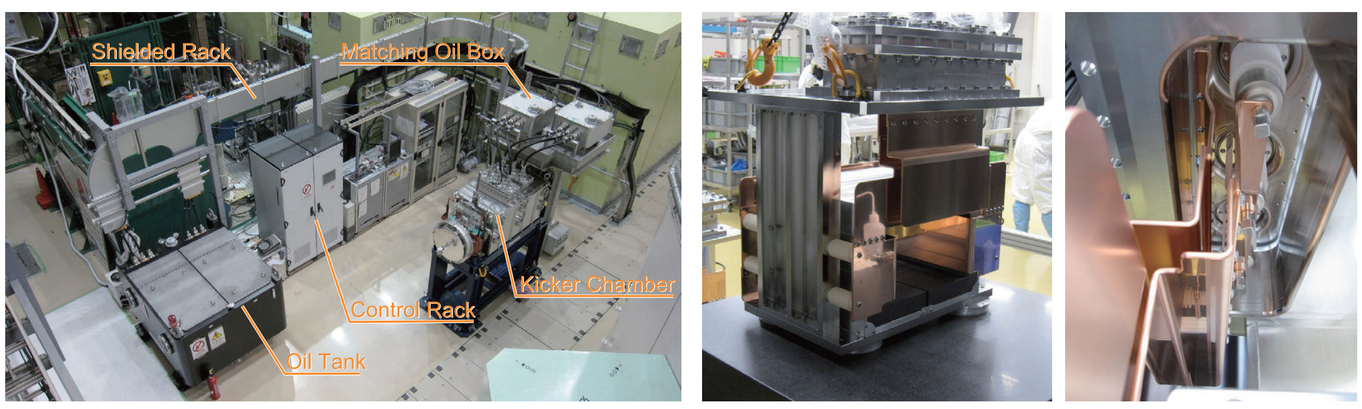


Kicker Power Supply

The kicker power supply was manufactured by Nihon Koshuha Co. Ltd. The adjustment using a dummy load was also performed. The main components of two kicker power supplies that can produced a pulsed current of 6300 A (corresponding to an excitation voltage of 45 kV) are set in an oil tank to reduce the inductance.



Kicker Magnet Commissioning Test at MLF



Power cables (20Ω x 3) connect the power supply to the kicker magnet in a shielded rack. Matching condensers are placed in two small oil boxes at the top of the kicker chamber. The ground of the kicker magnet is insulated from the ground of the beamline to reduce noise from the kicker operation to other equipments. The commissioning using the kicker magnet was unfortunately delayed due to the earthquake. It is now planned to start end of May 2011.