Development of Timing and Control Systems for Fast Beam Switch at KEK 8GeV Linac

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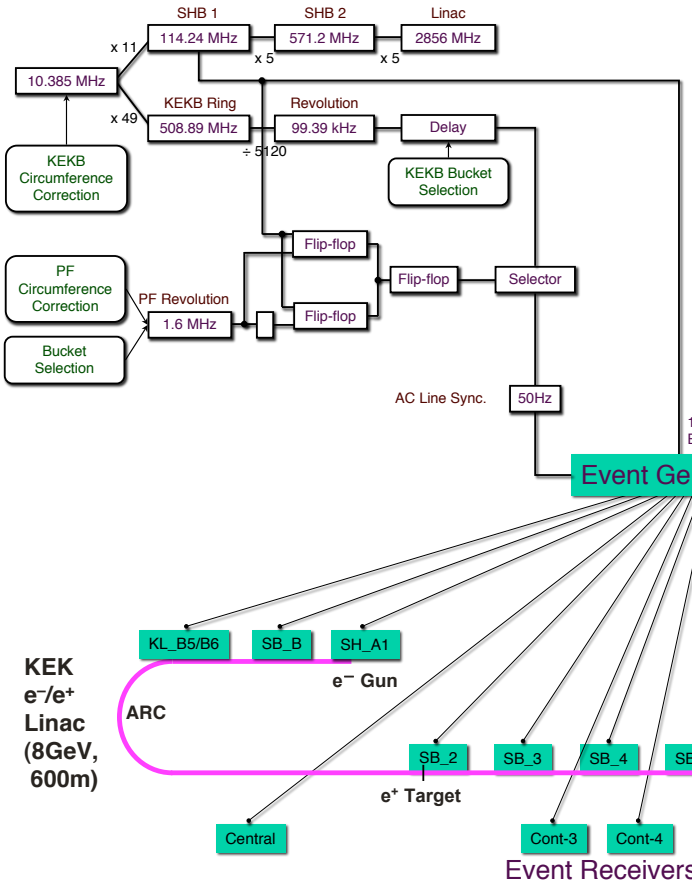
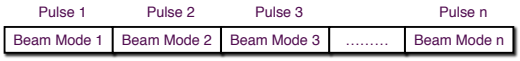
The 8 GeV Linac at KEK provides electrons and positrons to Photon Factory (PF) and B-Factory (KEKB). Simultaneous top-up injections have been considered for both PF and KEKB rings in order to improve the injection efficiency and the stability. Fast beam-switching mechanisms are being implemented, upgrading the timing and control systems. While the present system provides precise timing signals for 150 devices, many of the signals will be dynamically switched using an event system. A new scheme has been developed and tested to enable double-fold synchronization between rf signals. Fast controls of low-level rf, beam instrumentation, kickers, a gun, and beam operation parameters will also be upgraded for fast and precise tuning of those parameters. The system has been developed since 2006, and is being deployed for the autumn run in 2008.

rf Synchronization System



Beam Mode Pattern Buffer

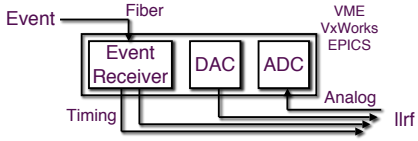


- Every pulse (every 20ms) corresponds to a beam mode.
- 10 different beam modes are defined (for KEKB e+, etc).
- One beam mode may contain many event codes.
- About 50 event codes are defined.
- Some events correspond to many functions, and others to specific devices.
- Beam pattern buffer length (n) can be 2 to 500 (20ms x 500 = 10 seconds).
- A new pattern can be loaded at the end of the previous pattern.
- Otherwise, the pattern repeats forever.
- Pattern generator software arbitrates requests from downstream rings.
- There are many pattern rules due to pulse device features and limitations.

Event System

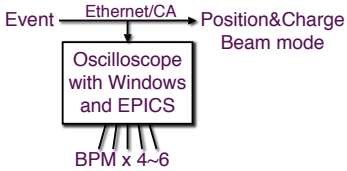
- MRF's series-230 Event Generator and Event Receivers.
- Multi-mode (62 μm) and single-mode (10 μm) fibers.
- VME64x standard and VxWorks v5.5.1 (or RTEMS v4.7).
- 114.24MHz event rate.
- 11 event receivers for now.
- Timing precision is less than 10ps jitter.

Rf Controls



- Slow rf controls are replaced with fast event systems.
- Timing and analog signals are essential for absolute energy, energy spread, and dual-bunch energy equalization.
- Signals can be switched pulse-by-pulse.
- Driver klystrons (SB), energy tuner klystron (KL), and sub-harmonic bunchers (SH) are managed by the event system.
- rf measurement system will be synchronized to events.

Beam Instrumentation



- DPO7104 can acquire data in 50Hz .
- Beam modes are recognized by events through network.
- Clients can monitor data of an interested beam mode.
- 100 BPMs are synchronized.
- Streak cameras and wire scanners will be synchronized to events as well.

Other sub-systems

- Pulsed bending magnet and pulsed steering coils.
- Gun pulser selection, voltage, and precise delay.
- Injection septa, and kickers.
- Beam orbit and energy feedback systems.
- Parameter manipulation, and archiving.
- Event system integrity monitor (continuous TDC).
- Safety interlocks.