



Event-based Timing and Control System for Fast Beam Switching at KEK 8-GeV Linac

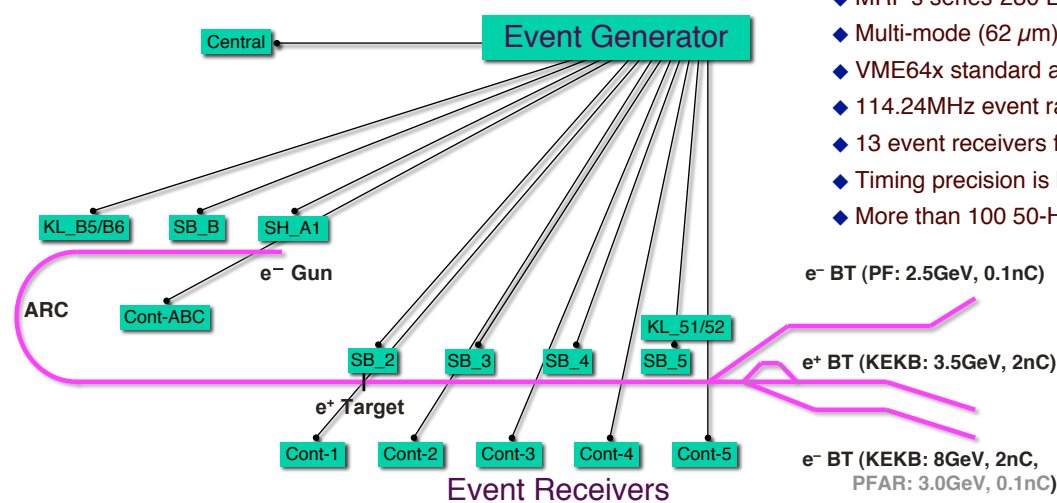


Kazuro Furukawa, Tsuyoshi Suwada, Masanori Satoh - High Energy Accelerator Research Organization (KEK)
 Takuya Kudou, Shiro Kusano - Mitsubishi Electric System and Service (MELCO SC)
 Artem Kazakov - Graduate University for Advanced Studies (SOKENDAI)
 Liyang Zhao - Shanghai Institute of Applied Physics (SINAP)

The 8-GeV linac at KEK provides electrons and positrons to several accelerator facilities. The 50-Hz beam-mode switching system has been constructed in order to realize the simultaneous top-up injections for Photon Factory and the KEKB high- and low-energy rings, which require different beam characteristics. An event-based timing and control system was built to change the parameters of various accelerator components within 20 ms.

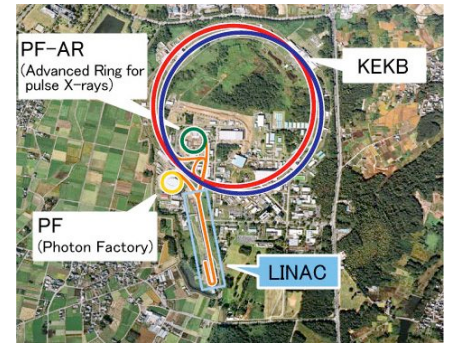
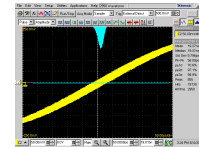
The components are spread over a 600-m linac and require changes to 100 timing and control parameters. The system has been operated successfully since autumn 2008 and has been improved on as beam operation experience has been accumulated. It is expected to enhance the quality of the experiments at KEKB and PF. We describe the details of this new and improved control system and present status of the accelerator operation.

Event System Configuration

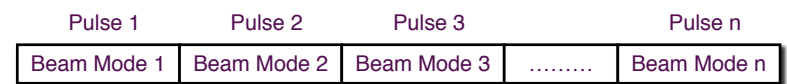


Event System

- ◆ MRF's series-230 Event Generator / Receivers.
- ◆ Multi-mode (62 μm) and single-mode (10 μm) fibers.
- ◆ VME64x standard and VxWorks v5.5.1.
- ◆ 114.24MHz event rate, 50Hz fiducials.
- ◆ 13 event receivers for now.
- ◆ Timing precision is less than 10ps.
- ◆ More than 100 50-Hz Analog/Timing PVs



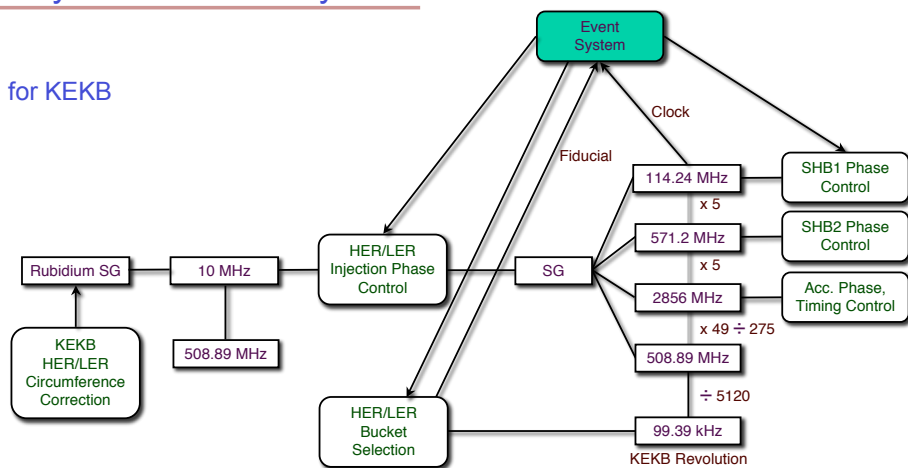
Beam Mode Pattern Generation



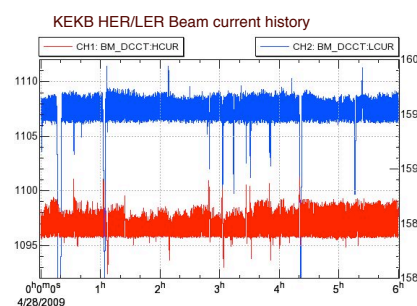
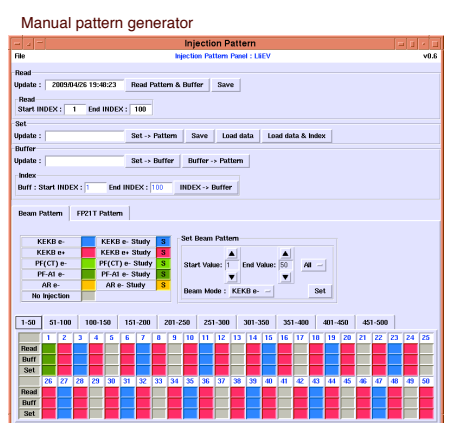
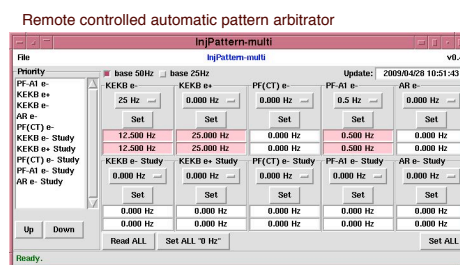
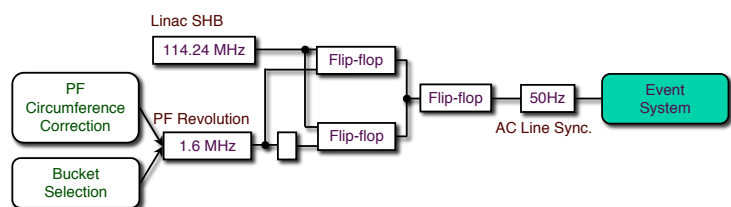
- ◆ Every pulse (every 20ms) corresponds to a beam mode.
- ◆ 10 different beam modes are defined (for KEKB e+, etc).
- ◆ One beam mode contain several event codes.
- ◆ Beam pattern buffer length (n) can be 2 to 500 (20ms x 500 = 10 seconds).
- ◆ A new pattern can be loaded at the end of the previous 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.

RF Synchronization System

for KEKB

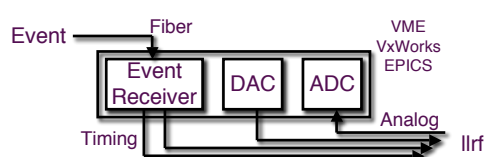


for PF



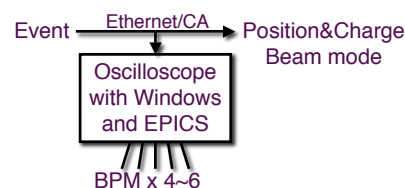
- ◆ Automatic injection program or human operator may change the beam mode pattern very often
- ◆ Typical operations at April 2009 is
 - ◆ KEKB HER ~12.5Hz
 - ◆ KEKB LER ~25Hz
 - ◆ PF 0.5Hz
- ◆ As stable operation was achieved, the rates will be lower.

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 klystrons (KL), and sub-harmonic bunchers (SH) are managed.

Beam Instrumentation



- ◆ DPO7104 with embedded EPICS can acquire data at 50Hz.
- ◆ Beam modes are recognized by events through network.
- ◆ Clients can monitor data of an interested beam mode.
- ◆ 100 BPMs are synchronized.

Summary

- ◆ The system successfully runs since summer 2008.
- ◆ Simultaneous injections are carried for 3 rings.
- ◆ Beam current stabilities (as of April 2009)
 - ◆ KEKB HER / LER : within ~2mA (12.5 - 25Hz)
 - ◆ PF ring : within ~0.1mA (0.5Hz)
- ◆ Will be further improved
 - ◆ Integrity monitor system
 - ◆ Beam and equipment monitor system
 - ◆ Beam operation scheme