DESIGN AND CONSTRUCTION OF THE PEFP TIMING SYSTEM FOR A 20MEV PROTON BEAM*

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Abstract

The timing system of the proton accelerator of the PEFP requires synchronization between the accelerator and the multipurpose beam lines. The system is based on an event distribution system that broadcasts the timing information globally to all the equipment. Fast I/O hardware of the timing system is to distribute appropriate timing signals to accelerator systems, including the Injector, RFQ, DTL, and user's facilities. Signals include the synchronized pulse triggers and event information of RF system and switching magnet power supplies for the 20MeV proton beam extraction.

INTRODUCTION

The PEFP(Proton Engineering Frontier Project) has two beam extraction lines at 20 MeV and 100MeV for a proton beam utilization. Figure 1 shows the 20MeV extraction beam line in front of DTL2 for 100MeV proton beams. 20MeV proton beam is extracted by a bending magnet and distributed to beam lines by a switching AC magnet [1]. Timing system is used for synchronization beam pulses of the ion source, the RF system of the RFQ and DTL, and the AC magnet power supply.

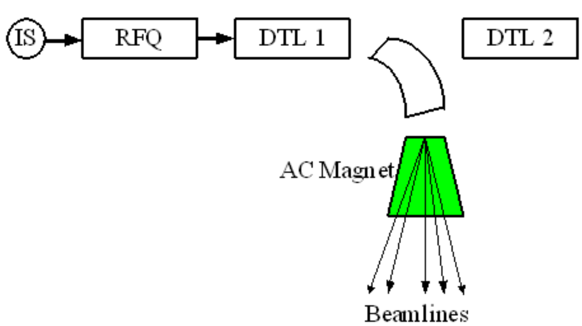

Figure 1: 20MeV extraction beam line between DTL1 (3MeV~20MeV) and DTL2(20MeV~100MeV).

The timing system should have the following functions:

- Clock synchronization between sub-system in IOC
- RF gate generation
- Beam gate generation
- Triggering for beam diagnostics
- AC magnet gate generation

We chose the event system as a timing system to synchronize the sub-instruments. This system is based on a event system developed by the APS (Advanced Photon Source) [2][3]. We redesigned the event system in order to include the signal distribution of the switching magnet. But enhancements and additional functionality of the redesigned system enabled us to use the event system including timing distribution of switching magnet. The PEFP event system is based on the global distribution of timing signals such as beams, RF gates and AC magnet pulse. 8 triggers of the beam and RF per single pulse of AC magnet are needed. This can support pulses up to 5 beam lines per switching magnet pulse. Duties and delays of the pulses should be variable respectively. We could use the software supported by EPICS community and integrate the event system [4].

DESIGN AND CONSTRUCTION OF EVENT SYSTEM

As shown in Figure 2 the event system is VME based control system that is adopted with upgraded event generator (EVG200), and its receivers (EVR200). Event generators broadcast timing events over fiber optic links to event receivers which are programmed to decode specific events. Event generator generates events in response to external triggers from internal programmable event sequence RAMs or from VME bus writes. The event receivers were programmed to generate and send both pulse and set/reset level outputs to synchronize proton beam, RF, and AC magnet. Figure 3 shows the picture of the developed system.

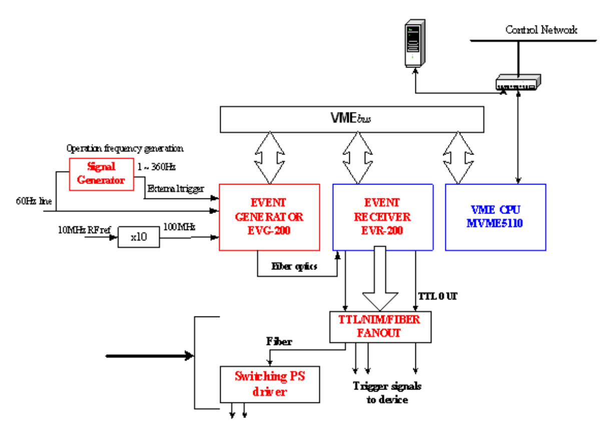

Figure 2: Schematic diagram of the Event System for a 20MeV beam line

The trigger signals needed for synchronization between accelerator and beam lines are applied to the EVG. Then all timing information is converted to 8 bit wide event

* This work is supported by the 21C Frontier R&D program in the Ministry of Science and Technology of the Korean government.
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codes and is transmitted at 50 Mbytes/sec via fiber optic links running at the speed of 100 Mbytes/sec to the 2 event receivers. EVG has two 512 Kbytes sequence RAMs, each of which can be enabled to transmit its contents to an external trigger of the event receivers. The sequence RAM is finally used as a trigger clock of the beam, RF, and AC magnet.

Figure 3: Picture of developed VME based event system

Event receivers can respond to the incoming event codes in different ways as well as recover the status of the signals on the distributed bus.

As shown in Figure 2 we need 8 pulses of RF and beam per an AC magnet pulse period. Each duty and delay of these pulses is controlled by referring the sequence RAM clock from the event generator. We grouped 8 trigger pulses and used the first trigger of them to generate a gate pulse for AC magnet. This process was performed at a fanout module.

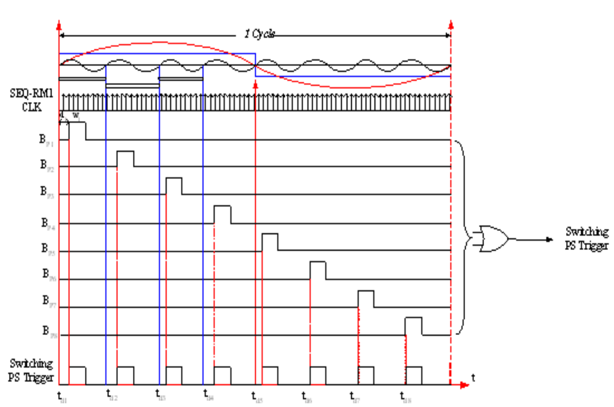

Figure 4: Trigger patten for triggering AC Magnet PS

Figure 5 shows a block diagram of the fanout board for AC magnet power supply and it is installed at the back of event receiver. All pulse widths are limited below 1.4ms at 60Hz.

The device drivers supported by EPICS community were modified to satisfy the operating mode. The application software was made on the "eg" and "er" of the EPICS record/device supports, which mainly interact with the registers mapped on the VME memory. CA(Channel Access) environments in the core of the EPICS were programmed for operators access.

We used EPICS extension applications such as EDM (Extensible Display Manager). This application was installed on host computer. The host computer also serves as a development environment for VxWorks which is the operating system for CPU of the event system (MVME5100). X-terminals are used as an operator interface in the PEFP.

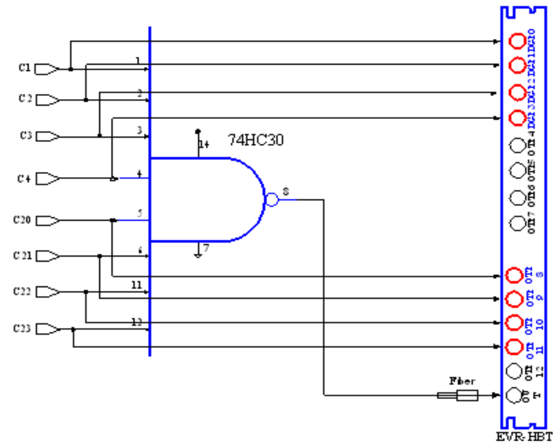

Figure 5: Trigger fanout board block diagram for AC magnet power supply

The event control system is located at a klystron gallery while the magnet power supply is located at a user facility and we use an optical fiber between them. Optical signal generated by fanout of the event receiver is sent to AC magnet PS driver module. This board can support 2 channels of optical inputs, a channel of optical output, and 3 channels of TTL outputs. As shown in figure 6, optical signal is converted to electrical TTL signal to trigger AC magnet power supply in this module.

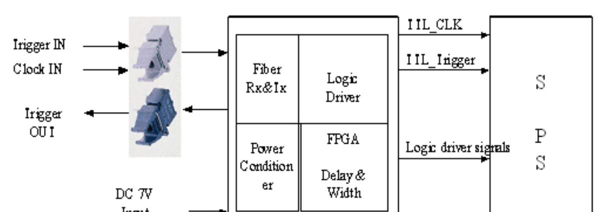

Figure 6: Trigger signal flows of AC magnet PS driver module

GUI(Graphic User Interface), putting on/off knobs and setting duty and delay, was programmed to test the required trigger signal. We could obtain stable TTL pulse signals as shown in Figure 7. AC magnet pulse was triggered by detecting rising edge of an external signal source.

We got a signal from external source and divided it into 8 pulses in order to supply RF and beam trigger signals.

We were able to set delay and duty of the pulses respectively referred to the first trigger signal of RF and beam. Besides, we checked shut off of pulses by external interlock signals.

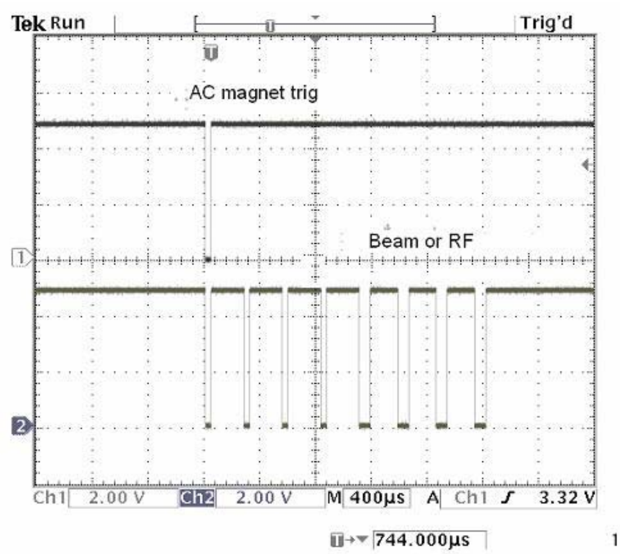

Figure 7: Trigger signals acquired from oscilloscope

SUMMARY

- We designed and constructed an event system for trigger signals to RF, ion source, and AC magnet power supply. This system consists of an event generator, receivers, fanouts, and AC magnet driver module (optical to TTL converter).
- The test results showed that the event system satisfied the design requirements.

REFERENCES

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