

BNB Accelerator Control Signal Availability

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The purpose of this document is to describe how each signal relevant to the timing of the BNB experiments is generated and where these signals are available. Presently, the signals common to MiniBooNE, LArTF, SciBooNE, and SBN Near and Far Detector buildings is the Tevatron clock (TCLK) and Main Injector beam sync (MIBS) clock. A copy of the Booster RF (BRF), Booster extraction sync (BES), and both the BNB and NuMI resistive wall current monitor (RWM) signals will be available on fiber at all active experiment buildings in the future.

TCLK is generated by a front end called the timeline generator (TLG) and is broadcast at 10 MHz to each accelerator service building. Main control room personnel change the timeline based on the requests of the experiments and the needs of the HEP program. The TCLK signal carries individual encoded events, which have hexadecimal values \$00 to \$FF. The control devices which are decoding these events are programmed to treat each accordingly.

As an example, a \$1D is known systematically as a Booster event for BNB beam. Most devices are waiting to decode the \$1D command and are programmed to output a signal following a delay of so many RF cycles (RFC), nanoseconds, microseconds or milliseconds, or some combination of these, which is often settable via ACNET. The controls system used to read the voltage on a beam loss monitor is triggered on the \$1D and is set to delay its reading by 47 ms.

MIBS is like TCLK in that the signal carries encoded events that devices are decoding, but the frequency of MIBS is locked to the Main Injector RF, which sweeps from 52.8 MHz to 53.1 MHz every cycle. The MIBS \$74 event is broadcast when 120 GeV protons are extracted from Main Injector to NuMI. The TCLK \$A9 is generated from the MIBS \$74 and is broadcast over the TCLK link to signal that beam was extracted.

TCLK and MIBS are patched into a repeater at each service building and require an IRM or VME crate with appropriate decoders to use these signals. TCLK decoders offer eight channels which can be configured to output eight different TCLK event triggers, each with a settable pulse width and delay in milliseconds. MIBS decoders offer four channels which are hard coded to output the MIBS \$74 and have settable pulse widths and delays.

BRF and BES originate in the Booster low level RF (LLRF) room and are converted from copper to TTL at the MI-12 service building with a fiber transmitter. BRF sweeps from 37.7 MHz to 52.8 MHz at a rate of 15 Hz. The BES signal indicates that 8 GeV protons will potentially be extracted from Booster, regardless of what their downstream destination is. BES is broadcast whether beam is permitted and present or not.

BES and BRF are used to generate a delayed BES signal from a Tawzer module in the MI-12 service building. The number of BRF cycles by which BES is delayed is settable on ACNET. This signal is presently available at MiniBooNE, LArTF and the SBN Near Detector, but will not be supported by Accelerator Division when fiber BRF and BES signals become available to active experiments.

BNB beam travels through an RWM which picks up the 1.6 μ s long, 52.8 MHz signal of the 81 individual 18.9 ns wide bunches that come with each batch sent to the BNB target. That signal is digitized in the MI12 service building.

The NuMI RWM picks up the 11.1 μ s long, 53.1 MHz signal of the 486 individual 18.8 ns wide bunches that come with each batch sent to the NuMI target and is treated similarly at MI-60.

A multi-functioning timing unit (MFTU) can decode TCLK and four other possible inputs, such as MIBS, BRF or BES. Output channels can be programmed to decode 16 different TCLK events to arm the device. The other input signals can be used to delay and trigger the MFTU output signal. These delays are settable on ACNET.

Raw RF and TTL signals come from their various origins and arrive at the MI-12 service building. TTL to Fiber Transmitters and Fiber to TTL Receivers, which exist to support the MFTUs, convert these signals to fiber or copper depending on where they are being used. For example, copper BRF is converted to fiber at the MI-12 service building using the TTL to Fiber Transmitter. That fiber signal is sent out to other buildings and is converted back to copper with a Fiber to TTL Receiver when it is to be used by an MFTU, which only generates delays using copper signals.

TCLK, MIBS, BRF and BES and will later be available to the MiniBooNE, LArTF, MINOS, and SBN Near and Far Detector buildings from an MFTU. The BNB and NuMI RWM signals will be available from the Fiber to TTL receivers. All these signals can be carried from their local outputs on LEMO-terminated copper cables.