

Main Injector Beam Line Tuner Front-end Operation

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A Recycler Ring (RR) Beam Position Monitor (BPM) front-end has been installed into the Main Injector (MI) to support Beam Line Tuner (BLT) operation for that machine. This BLT front-end is nearly identical to the RR BPM front-ends with only minor modifications to the measurement triggering subsystem to handle the unique MI requirements. No special BLT processing is provided by the front-end which simply collects and returns turn-by-turn position and intensity data to ACNet where an application program performs BLT specific calculations at the application program level.

The BLT front-end is configured for operation with **2.5 MHz bunched proton and antiproton injection from the Recycler** and **2.5 MHz bunched antiproton injection from the Accumulator stacking and shot lattices**. The MI-60 wide band stripline is used. The horizontal plane is associated with Q-602 (H602) and vertical plane with Q-603 (V603).

For a detailed description of the triggered measurement and data readout operations of the BPM/BLT system or to learn how to sample other beam flavors see “Event Driven Data Acquisition for the Recycler Ring BPM Front-end” (Beams-doc-800). A summary of the most important BLT configuration parameters follows.

BLT measurements are configured through acquisition specifications made available via ACNet device I:BLTACQ. Five of the sixteen possible specifications are used in the system:

- #2 – **Recycler Protons to Main Injector,**
- #3 – **Recycler Antiprotons to Main Injector,**
- #4 – **Accumulator Antiprotons through MI to Recycler,**
- #5 – **Accumulator Antiprotons through MI to Tevatron and**
- #15 – **Accumulator Antiprotons to Main Injector prearm.**

The five acquisition specifications (see tables below for specification values) are loaded into the BLT front-end by ACNet at boot time and are treated as if they are constants.

This means that once loaded they remain active and the BLT front-end will make the specified measurements, without intervention, each time the specified arm/trigger conditions are met. The engineering and diagnostics application program mentioned below may be used to modify or add additional acquisition specifications.

Accumulator Related Acquisition Specifications

Event Index 4 – Accumulator Antiprotons through MI to Recycler:

_enable	kAcquisitionOff
_measurement	kOneShotMultipleGate
_beamMode	kAntiproton
_beamType	kInjectExtract
_measurementType	k2_5MHzEnsemble
_armEvent	0xE0
_triggerEvent	0x7A
_pretriggerEnable	kPretriggerDelayOff
_triggerDelay	26
_globalDelay	200
_intensityThreshold	0.0
_timeout	10

Event Index 5 – Accumulator Antiprotons through MI to Tevatron:

_enable	kAcquisitionOff
_measurement	kOneShotMultipleGate
_beamMode	kAntiproton
_beamType	kInjectExtract
_measurementType	k2_5MHzEnsemble
_armEvent	0x40
_triggerEvent	0x7A
_pretriggerEnable	kPretriggerDelayOff
_triggerDelay	26
_globalDelay	200
_intensityThreshold	0.0
_timeout	10

Event Index 15 – Accumulator Antiprotons to Main Injector prearm:

_enable	kAcquisitionOn
_measurement	kPream
_beamMode	kAntiproton
_beamType	kInjectExtract
_measurementType	k2_5MHzEnsemble
_armEvent	0x91
_triggerEvent	kTriggerAutomatic
_pretriggerEnable	kPretriggerDelayOff
_triggerDelay	(5 << 4) + 4 = 84
_globalDelay	0
_intensityThreshold	0.0
_timeout	60

The unique MI requirements of multiple event arm sequences on Tclk, and trigger events originating on either the RR or MI Bsync clock are met by minor modifications of the hardware and software of the RR BPM front-end trigger subsystem. Measurements associated with Accumulator transfers (event indices 4 and 5) are triggered with the assistance of a ‘dummy’ measurement programmed into the acquisition specification for event index 15. The ‘dummy’ measurement acts as an arm event qualifier on Tclk \$91 which signals the beginning of Accumulator transfer sequences. The ‘dummy’ measurement acts as a simple state machine for Accumulator transfer triggers by enabling and disabling the appropriate acquisition specifications at the correct times. Note that the acquisition specifications for event indices 4 and 5 are configured as kAcquisitionOff since they are controlled by the prearm function. The acquisition specification event indices requiring prearm support are encoded into the triggerDelay field of the event index 15 acquisition specification, four bits at a time, as indicated in the above table.

Recycler Related Acquisition Specifications

Event Index 2 - Recycler Protons to Main Injector:

_enable	kAcquisitionOn
_measurement	kOneShotMultipleGate
_beamMode	kProton
_beamType	kInjectExtract
_measurementType	k2_5MHzEnsemble
_armEvent	0xE3
_triggerEvent	0x1A3
_pretriggerEnable	kPretriggerDelayOff
_triggerDelay	35
_globalDelay	200
_intensityThreshold	0.0
_timeout	10

Event Index 3 –Recycler Antiprotons to Main Injector:

_enable	kAcquisitionOn
_measurement	kOneShotMultipleGate
_beamMode	kAntiproton
_beamType	kInjectExtract
_measurementType	k2_5MHzEnsemble
_armEvent	0xE4
_triggerEvent	0x1A7
_pretriggerEnable	kPretriggerDelayOff
_triggerDelay	36
_globalDelay	210
_intensityThreshold	0.0
_timeout	10

The trigger event field of the Recycler related acquisition specifications contains a value of 0x00010000 plus the value of the desired Bsync clock event to indicate that the event is transmitted on the RR rather than the MI Bsync clock. This ‘flag’ bit instructs the timing signal generator’s trigger logic to switch from the MI Bsync clock to the RR Bsync clock for trigger event detection. Note that although measurement triggers may originate on the MI or RR Bsync clock, the MI beam synchronous 53 MHz clock and MI Bsync \$AA turn marker are used for timing on all measurements regardless of the beam origin.

Data readout configuration is accomplished through the turn-by-turn Readout Specification made available via ACNet device I:BLTTBS. Readout specifications cannot be loaded at boot time because they contain measurement dependent information. Set the readout specification¹ immediately prior to reading measurement data to assure data correctness.

Valid readout specification field values for I:BLTTBS are listed below. Position and intensity data are available by reading the I:BLTTBV ACNet device.

<code>_eventIndex</code>	2, 3, 4 or 5
<code>_dataType</code>	kBunchedData
<code>_beginTurn</code>	1 . . 1024
<code>_numTurns</code>	1 . . 1024
<code>_channel</code>	0 or 1

Channel #0 contains horizontal data and channel #1 contains vertical data. Note that the sum of the `_beginTurn` and `_numTurns` field values may not exceed 2048.

The Recycler BPM engineering and diagnostics application program R25 has been enhanced to support operation of the BLT front-end. It is possible to manipulate the BLT timing and scaling parameters, and acquisition specifications may be modified or added with the program.

End.

¹ The protocol for data readout described in “Event Driven Data Acquisition for the Recycler Ring BPM Front-end” (Beams-doc-800) must be followed to assure that the expected data are received.