MI-8 Collimator Loss Monitors

Local application

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Four collimator beam loss monitors are used in the Main Injector MI-8 beam line. Two are at location 836 and two are at location 838. A local application called `LM8C` computes various average readings for each type of beam cycle. This note describes its operation.

The parameter layout is as follows:

Param		*Size*	*Meaning*
`ENABLE`	`B`	2	Usual LA enable Bit#
`BLM`	`C`	2	First beam loss monitor Chan# (of 4)
`MATRIX`	`C`	2	Matrix constants for conversion to E10 protons/sec loss
`PEDSTAL`	`C`	2	Pedestal results base Chan#, in rads/sec units
`LOSS`	`C`	2	Instant, average results base Chan#
`TOTAL2`	`C`	2	Instant, average pair results base Chan#, in E10 units
`TOTAL4`	`C`	2	Instant, average quad results base Chan#
`TARGNODE`		2	Target node# for acquiring input readings, matrix constants, events

This LA handles four loss monitor readings. Correspondingly, it computes four average pedestal values, four arrays of instantaneous results and four arrays of average results. In addition, it does the same for each pair, and for all four as well.

The array elements relate to beam cycles according to the following Booster beam clock events:

`0x52`, `0x13`, `0x14`, `0x15`, `0x16`, `0x17`, `0x19`, `0x1C` and `0x1D`, plus an unused spare, a total of 10.

The input loss monitor readings are converted from volts to rads/sec units via this formula:

```
L = 0.0015 * 10^(V/1.688) = 0.0015 * exp(1.3641*V)
```

To compute an average pedestal reading, a reading on a powered non-beam cycle (event `0x12`) is converted to rads/sec, and the resulting value is averaged over 20 cycles.

On any beam cycle, signaled by event `0x52` plus a specific `0x1x` event from the above list, each pair of input loss readings is converted first to rads/sec and, after subtracting the pedestals, are `L1`, `L2`. These two loss values are combined using matrix elements `T11`, `T12`, `T21`, and `T22`:

```
P1 = L1 * T11 + L2 * T12
P2 = L1 * T21 + L2 * T22
```

A separate set of matrix constants is used for each pair of loss readings.

Each of these proton loss values, in units of `E10`, is sampled as an instantaneous value for the current beam cycle event type and also as a value to be used in building a sliding average, where each average result covers the most recent 20 cycles of that same event type.

The `TARGNODE` parameter permits running the LA in a test node while accessing the real data from the target node. That data includes not only the input loss data but also the clock event data and the matrix constants. Note that this method means that installing the LA into the target node does not require any changes in the LA, as the underlying system knows how to find the data.

Details

All matrix elements, pedestal values, and both instantaneous and average results are defined as raw floating point channels, where the only values they have are the values they are born with; no additional scaling is done in the front end.

The matrix elements are settable so a user can alter them as loss monitor hardware characteristics change over time. The LA also ensures that the setting values are reflected in the reading values.

To assist in building the required sliding averages, an internal structure is used of this form:

Field	*Size*	*Meaning*
`hx`	2	index to next array element
`cyc`	2	cycle# of last event occurrence (or event# as debugging aid)
`total`	4	total #entries ever entered into circular array
`hist`	20*4	array of most recent values to build average

Soon after initialization of `LM8C`, there may be less than 20 values yet collected for building an average. In that case, shown by the value of `total`, only the number of entries yet placed is used.

In order to assist with debugging/monitoring, the array in each history structure is padded to 30 entries, so that its complete size is 128 bytes, or 2 "memory dump" pages. But the averages only cover the most recent 20 cycles of the related event byte.

The sequence of channels for results are arrays of 10 clock events, with the array of averages following the array of instantaneous values. There are 4 such series of 10 channels. In a similar way, there are two sets of paired instantaneous arrays, each followed by an average array. Finally, there is an array of quad instantaneous losses followed by an array of corresponding averages. All in all, there are 4*2*10 + 2*2*10 + 2*10 = 140 result channels derived from the 4 BLM readings.