LHC Beam Loss Monitor

Post Mortem & Memory Requirements

Design Considerations 2:

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Functional Specifications

12/03/03: LHC-BLM-ES-001.00

POST-MORTEM ANALYSIS (chap. 6.9 & 9.8)

- In case of a beam dump, the BLM system should help answering the following questions:
  - ➔ is the beam dumping clean or were there unexpected losses around the machine?
  - ➔ what is the cause of the dump action: beam losses triggering the BLM or internal magnet quench protection interlocks? Other machine interlocks without prior beam losses?
- The signals of all monitors should be buffered for the last 100 - 1000 turns, such that they can be read out and analysed after a beam-dump. In addition, the average rates of all monitors should be easily available for time scales of a few seconds and 10 minutes before a beam-dump.

PM equipment “categories”

13/12/01: General ideas on the PM system (J. Wenninger)

We can sub-divide the various LHC systems into the following categories:

- **Triggered systems (via specific external event) :**
  - beam instrumentation
  - power converter system
  - RF system
  - …
- **Self-triggered systems :**
  - quench protection system
  - beam dump system
  - power converter system (on faults ?)
  - …
- **Non-triggered systems :**
  - Interlock system, BIC & PIC

Protection Systems

LHC Workshop, Charmonix XI-8.4; R. Lauckner

- Transient
  - ➔ System required to record fast signals and freeze on trigger
- Logging
  - ➔ System required to continuously (on time or on change) record slow or infrequent changes
- Alarms
  - ➔ System required to send fault events to the Central Alarm Server, (CAS).
- External Trigger
  - ➔ System required to respond to general PM trigger
- Internal Trigger
  - ➔ System required to autonomously record all protection actions
- Date
  - ➔ Operational for Sector Test or Beam Commissioning

Protection Systems

LHC Workshop, Charmonix XI-8.4; R. Lauckner

- The correct functioning of all these systems is required to ensure proper protection of equipment.

(Beam Dumping System, Beam Loss Monitors, Energy Extraction Switches, Quench Protection, etc)

- **Beam Loss Monitors:**

They are included here as a critical part of the machine protection system, their status should be logged.

Beam loss information should be recorded

at **100 Hz, depth 20s**

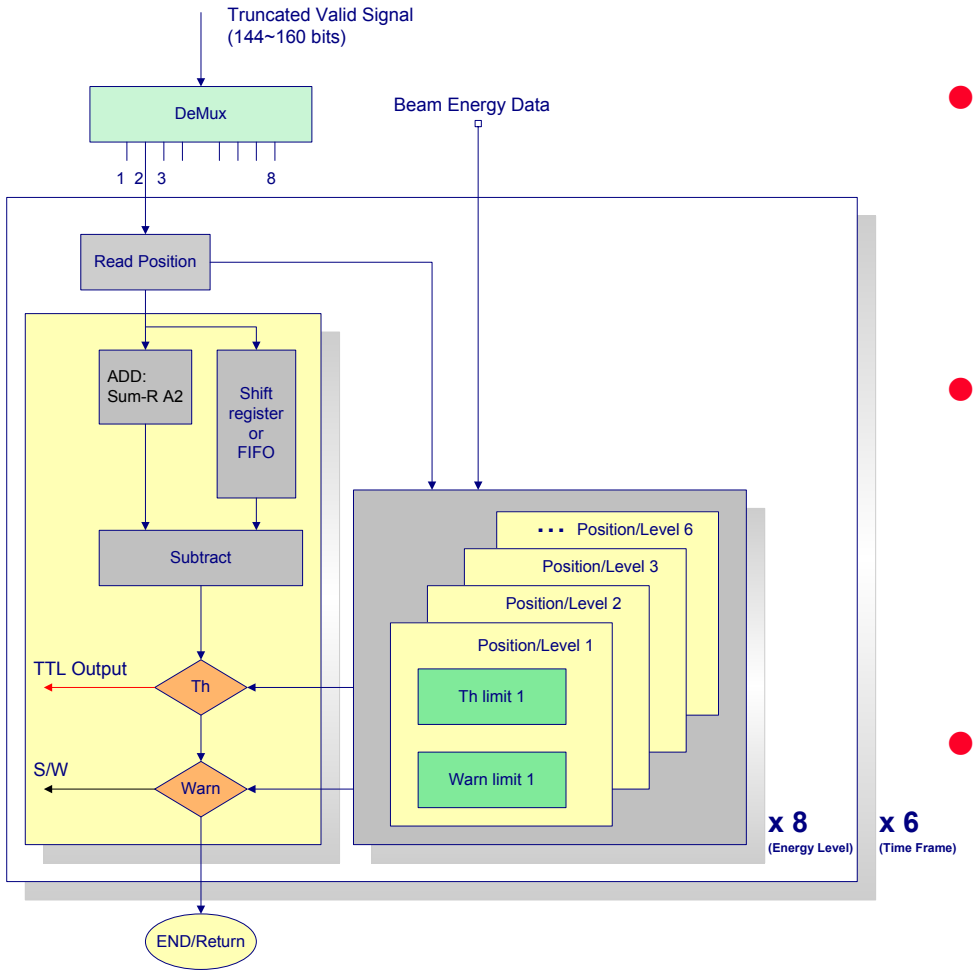
or

Beam Loss 2000 channels * 100Hz * 20s = 4E6 values

(Note: Beam Position 2000 channels * 1000 T = 2 E6 values)

Threshold Comparator (1)

Threshold Comparator System Using Sum-Registers



- **Observation Time-Windows**
  - Adding newest data
  - Subtracting oldest data
  - Capacity of FIFO
- ***Th* & *W* table** values depending on:
  - Beam Energy
  - Ion. Chamber Position
  - Time-Window

  Read 2 values from a table of 576 values
- **Comparisons on chip**
  - 96 times in parallel (6 TimeWind.*16 Ion)

Calculations

- **Acquisition every 40μs:**
  - 25 KHz
  - 16 Ion. Chambers per Card.
  - 8 bit values

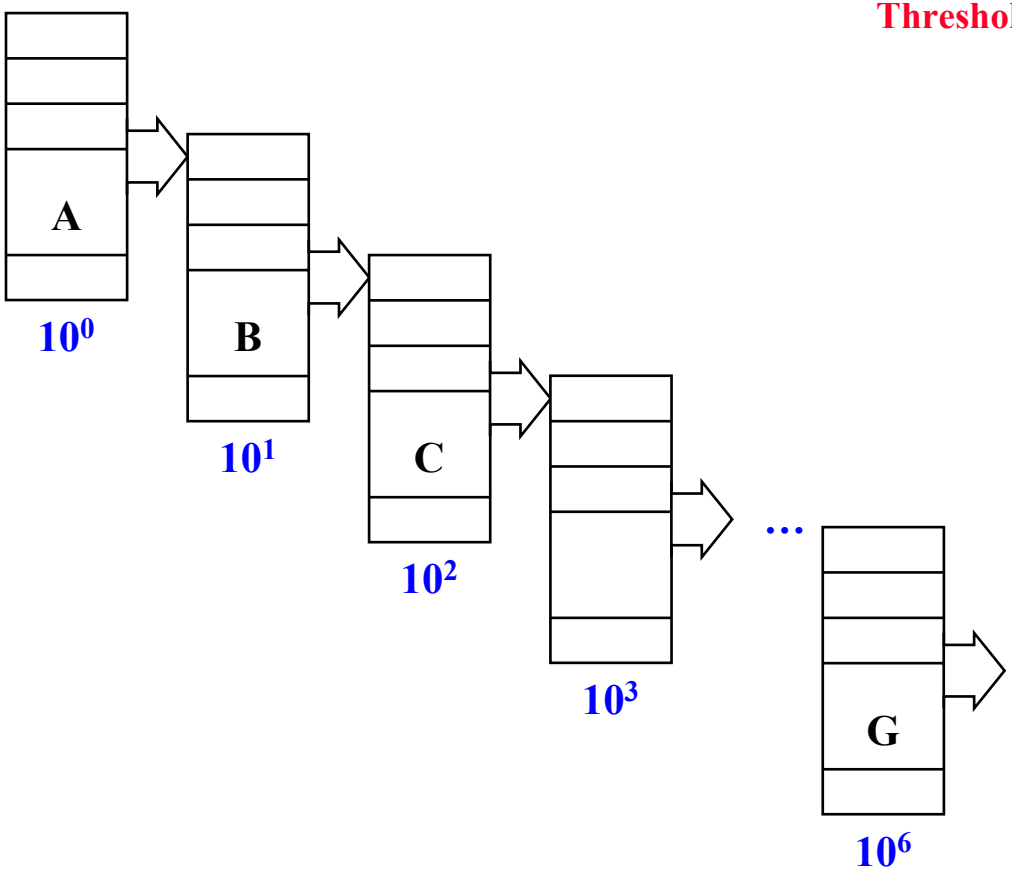
- 1024K x 36bit SRAM can hold 10.24s of data
  - Write Clock = 400 KHz & Read Clock = 2.4 MHz
  - 10 seconds need 250K x 8bit per Ion. Chamber.

- **Acquisition every 90μs (1 turn):**
  - 11 KHz
  - 16 Ion. Chambers per Card.
  - 8 bit values

- 1024K x 36bit SRAM can hold 23.04s of data
  - Write Clock = 180 KHz & Read Clock = 1.1 MHz
  - 10 seconds need 110K x 8bit per Ion. Chamber.

*Note that 2 SRAMs can be available to keep the data under manipulation and 1 SRAM for PM.

Threshold Comparator (2)



- **Disadvantages:**
  - ➔ **Slower update rate**
- **Advantages:**
  - ➔ **Sums are available constantly for comparison**
  - ➔ **Ability for comparisons up to 100s+**
  - ➔ **TC can have a lot more intermediate time windows.**

When A has been filled with 10 acquisition values, the sum of them is appended as a value to B.
When B has been filled with 10 values, the sum of them is appended as a value to C, and so on.
In that way sums of tenths, hundreds, thousands, millions, … of values are created and kept.

Calculations(2)

Quench Levels as a number of clocks

CFC		Beam Loss SPS	
Frequency	0.1 - 5.00E+06 Hz	**Length**	19cm
Current	20 - 1.00E+06 pA	**Surface**	63cm^2
Dynamic	5.00E+07	**Volume**	1000cm^3
Resolution	200 pC/clock	**Resolution**	2500ch./Mip
	1.25E+09 elect./clock	**High Voltage**	1500V
	5.00E+05 Mips/clock	**Rise Time**	~100ns
Clock max	5.00E+02 clock/0.1ms	**Fall Time**	~100μs

Fluence		.45TeV		7TeV	
		min	max	min	max
BL ARC	Mips/cm^2/p	5.00E-04	3.00E-03	8.00E-03	4.00E-02
	Mips/63cm^2/p	3.15E-02	1.89E-01	5.04E-01	2.52E+00

Quench Levels as number of clocks