Scaler Requirements for STAR

J.B. Carroll, H.J. Crawford, R.C. Jared, E.G. Judd, G.J. Kunde

This note describes the requirements for the STAR scalers. We assume that some set of monitor detectors and associated logic will be used to determine whether a particular monitor-type event has occurred in each RHIC crossing. It is the primary function of the scaler board to record the number of these occurrences whenever STAR is ready for data. This document does not present requirements for the luminosity (L) monitor detectors, nor does it address the issue of a background-free luminosity monitor.

Contents:

1. Live every crossing
2. Inputs
   - 2.1 Channels
   - 2.2 More channels
   - 2.3 Bits per channel
3. STAR status bits
4. RHIC status bits
   - 4.1 Bunch description
   - 4.2 Database changes
5. Readout
   - 5.1 Send to database
   - 5.2 Read and clear
   - 5.3 Independent operation
   - 5.4 Read frequencies
   - 5.5 Interference
   - 5.6 Time stamp
6. Initialization
7. Synchronization
8. Accuracy
9. In Events

1. Live every crossing

Requirement: The scalers must be "live" for every RHIC crossing when the STAR detector is in data taking mode.

Justification: Monitoring luminosity requires that we save a sum of the monitor-type events observed. Note that this implies that the readout of the scalers must not interfere with other aspects of STAR data taking, unless we allow the scaler readout to render STAR dead.

2. Inputs

2.1 Channels

R: The scaler board must allow at least 12 separate input channels for counting.

J: STAR needs at least 2 channels for a Luminosity monitor and a RHIC Strobe counter. In addition, we need to monitor the overall stability of the system. For this, a single channel is insufficient. We do not understand our interaction environment well enough to say what the best luminosity monitor for the spin program will be or the best stability monitors for STAR, but we believe we will have to investigate combinations of at least 3 thresholds on each of three detectors. These are assumed to be the CTB (covering $\equiv 1<\eta<1$), the MWC ($-2<\eta<-1$), and a multiplicity detector in the ($4<\eta<5$) region. We include 2 additional channels because we want a few spares.

2.2. More Channels

R: The scaler system design must be scaleable to allow addition of more channels as needed.

J: We are not sure how many scaler channels are needed for the final STAR system.

2.3 Bits per channel

R: The scaler board must accept either 0 or 1 as its input for each channel.

J: If we assume that the monitor events are Poisson distributed we can get all the information we need from a simple 0 or 1 as input. This implies that we are counting each crossing in which STAR is taking data.

3. STAR status

R: The scaler board must allow gating of input channels based on the status of the STAR detector system.

J: We need to accumulate sums based on live-ness status for each subsystem during each crossing. (If you want to know the integrated luminosity for any given state of STAR (TPC live, SVT off, etc.), you need to be able to cut on that state being "live".)

4. RHIC status

4.1 Bunch Descriptions:

R: The scaler board must allow gating of input channels based on the status of the RHIC accelerator system.

J: We need to record sums for different polarizations, etc., i.e., for different states of the beams at the intersection region. We assume this is represented entirely by a bunch number at any crossing (e.g., bunch 53 always crosses with bunch X, and RHIC provides a data-base-recorded value for the polarization state of each bunch in the ring). We expect at most 120 bunches per ring, or 240 total, but identifying the bunch in one ring specifies the bunch with which it interacts in the other.

4.2 RHIC database changes

R: The scaler board must be read and reset whenever the RHIC database bunch description changes.

J: we need to record values for the bunch descriptions that are current.

5. Readout

5.1 Readout to database

R: The STAR scalers must be readable by a process that can add scaler data to the STAR database.

J: Events in STAR are objects in the database.

5.2 Read and Clear

R: The readout of any channel must also clear that channel so that its content at the next read will reflect the period when it is next alive.

J: We need to have the channel count correspond to a clearly identified interval of RHIC and STAR operations.

5.3 Independent operation

R: The STAR scalers must be readable independent of the status of other STAR subsystems (except, of course, the subsystem controlling scaler readouts).

J: We need to monitor the status of RHIC even when STAR is turned off, primarily so that we can know whether it is “safe” to turn the detector on.

5.4 Readout Frequencies

5.4.1 R: High frequency : The scaler board must be able to be read as frequently as once per minute.

J: During tune-up and new fills we need to monitor the scalers closely in time to know when STAR and RHIC are operating appropriately for data taking.

5.4.2 R: Nominal rate: The scalers need to be read once every 5 minutes during normal operation.

J: A five minute interval is deemed appropriate for periodically checking the scalers for RHIC and STAR operation.

5.4.3 R: Low Frequency : The scaler board must be able to be read as infrequently as once per hour without losing any crossing's data.

J: We need to be able to record sums "on tape" at the end of a run to serve as a check on intermediate scaler readouts.

5.5 Interference

R: The scaler readout must interact with other processes in a fashion to minimize the loss of physics data.

J: The expected rate of change of scaler quantities leads to a low priority for frequent monitoring.

5.6 Time stamp

R: We must include an unambiguous identification for each scaler readout (ie, scaler event) that ties it clearly to the beginning crossing and ending crossing for which this data was collected.

J: We need to be able to correlate scaler values with triggered events.

6. Initialization

R: The scaler board must be able to be set to 0 (or some other value) in all channels.

J: This seems like a good way to start a run or running period.

7. Level 0 Synchronized

R: The scaler board must be synchronized with the level 0 trigger for each crossing.

J: The scaler sums should reflect the status at the crossing in which the trigger event occurred.

8. Accuracy

R: The scaler board must allow counting input hits with an error less than 1 part in 10^5.

J: This is the stated accuracy requirement for the Spin program (Reference?).

9. Scaler input bits in Events

R: The bit pattern that is input to the scalers must be recorded with each triggered event.

J: We need to be able to verify the operation of the scaler board as well as the prescale functions of the trigger.