Requirements for the STAR Trigger based on EMC

Introduction

In pp, pA, and AA collisions, the STAR EMC can be used to trigger on events applicable to the study of the gluon structure function, jet properties in heavy ion collisions (e.g. quenching), isospin fluctuations, and high p_t physics with photons and jets. The quark and antiquark spin structure function can be studied with $W^{\pm}$ and Z^{0}. In polarized pp collisions, the EMC can be used to study the gluon spin structure by triggering on W's and jets, and the transversity structure function by triggering on Z's, W's, γ's,and jets.

To trigger on these phenomena using the EMC, one must allow for selecting events based on

1. Jets
   Justification: The study of the gluon structure function and the gluon spin structure function.
2. Direct γ
   Justification: The study of the gluon structure function and gluon spin structure function

3. Electrons
   Justification: The study of J/ψ suppression, $W^{\pm}$, Z^{o} physics, heavy flavor studies via the semi-leptonic decays c -> e+X and b -> e+X in pp collisions. Electrons also allow, in situ, cross-calibration between TPC momentum and EMC energy via E/p

4. E_t - total transverse energy deposited in the EMC and its distribution, $d^2E_t/d\eta d\varphi$.

   Justification: Improve STAR's centrality trigger by measuring the neutral E_t which would otherwise be missed which comprises 30% of the emitted energy. E_t can also be a trigger for other high E_t processes such as direct γ's, jets and W's.

5. Abnormal isospin ratios

Justification: The study of disordered chiral condensates through fluctuations in charged to neutral energy ratio.

Note that the proposed physics studies require that the trigger optimize the maximum effective integrated luminosity as there will be information in the EMC detector for virtually every crossing. It is therefore essential that much of the triggering be done with the least amount of deadtime or no deadtime at all so as to prevent non-essential events from precluding events of interest. It should also be noted that EMC trigger data includes both tower and shower max detector input.

Requirements

1. Calibration Trigger

   Requirement: A calibration trigger must be supplied for absolute calibration of the EMC using sources, lasers, and charge injection.

   Justification: The EMC must be calibrated.

2. Single tower

   Requirement : Select events in which any single tower is above one of three programmable thresholds without introducing deadtime.

   Justification: Selection of potential e/γ events via their signature of a high tower. The three thresholds allow for prescaling of event triggers over a range of p_t . The condition of no deadtime is required to optimize the maximum effective integrated luminosity. There will be information in the EMC towers for virtually every crossing.

   Status : Under discussion

3. 4 Tower sums

   Requirement : Select events in which at least one 4 tower sum (nonoverlapping) is above programmable threshold without introducing deadtime.

   Justification: Increased efficiency for the selection of e/γ events via their signature of a high deposition of energy in a small, localized area . Four tower sums will also account for showers that cross tower boundaries that would otherwise be lost. About 15% loss in good events will occur without this trigger.

The condition of no deadtime is required to optimize the maximum effective integrated luminosity. There will be information in the EMC towers for virtually every crossing.

Status: Under discussion

4. 16 Tower sums

Requirement : select events in which at least one 16 tower sum (overlapping) is above programmable thresholds without introducing deadtime.

Justification: Selection of potential jets via their signature of broad energy deposition over a region in $(\Delta\eta,\Delta\varphi)$ of (0.4,0.4) as compared to the core a typical jet which has a radius $R = \sqrt{\Delta\eta^2 + \Delta\varphi^2} \approx 0.5$. The condition of no deadtime is required to optimize the maximum effective integrated luminosity. There will be information in the EMC towers for virtually every crossing.

Status : Under discussion

5. Global E_t

Requirement : select events in which Global E_t is above programmable thresholds without introducing deadtime.

Justification: Global E_t in pp and p-A collisions will provide a way to trigger on jet-jet and γ-jet events via the energy deposition. In AA collisions this trigger will also give a measure of the centrality or hardness of the collision. The condition of no deadtime is required to optimize the maximum effective integrated luminosity. There will be information in the EMC towers for virtually every crossing.

Status: under discussion

6. E_t patches

Requirement : Select events in which E_{CAL} / E_{CTB} in at least one of the 12 (η,φ) patches is above a programmable thresholds without introducing deadtime. Patches are fixed in (η,φ) space with size $(\Delta\eta,\Delta\varphi)$= (1,1).

Justification: Selection of events with anomalous isospin by comparing calorimeter patches with similar (η,φ) patches in the CTB which are sensitive to charged particles. Simulations have shown that this patch size will optimize the efficiency of the trigger. Allowing for three thresholds will premit prescaling over selected energy

ranges. The condition of no deadtime is required to optimize the maximum effective integrated luminosity. There will be information in the EMC towers for virtually every crossing.

Status: under discussion

7. Luminosity monitor

Requirement: Scaled trigger values will be generated corresponding to a luminosity measurement.

Justification: The luminosity of events associated with the EMC must be measured, especially for polarized pp running to reduce relative errors below 10^{-4} in spin physics studies.

Status: Proposed monitors on E_t above three thresholds, Multiplicity of the CTB above three thresholds, and combined MWC and CTB multiplicity.

8. Electrons and gammas

Requirement : Select events in which a localize energy cluster tower is above some programmable threshold and isolated, that is, the sum of neighboring towers is less than some programmable threshold.

Justification: Allows for selection of events having at least one e or γ. Background events will be due to jets with non-isolated energy distributions.

Status: under discussion

9. Jets

Requirement : Select events in which at least one multiple tower/cone is above some programmable threshold .
Justification: Allows for selection of events having at least one jet. Jets are the foundation of all high p_t physics. In pp and pA jets will be used to study the gluon structure function

Status: under discussion

10. Correlated multiple towers

Requirement: Select events with more than one tower and within a programmable spatial constraint. Such events would include γ-jet, di-jet, and di-electron.

Justification: Allows for the selection of events used in the the study of the gluon structure function i.e. gluon-quark scattering(γ-jet), quark-quark scattering(di-jet) and events involving J/ψ's (e-e).

Status: under discussion

11. Programmable Trigger

Requirement: A trigger capability that allows for future trigger demands not already specified.

Justification: STAR is a pioneering experiment in the field of relativistic heavy ion collisions and because of that new and interesting physics is anticipated whose triggers have yet to be defined. It is therefore highly desirable that the STAR trigger has the flexibility to impliment new triggers based on general arithmetic operations involving the EMC tower energies.