New trigger logic for the STAR forward meson spectrometer

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The STAR Forward Meson Spectrometer (FMS) is a Pb-glass electromagnetic calorimeter covering the forward rapidity region ($2.5 < \eta < 4$) in STAR. It is being used to explore a broad range of spin phenomena in *pp* collisions. During RHIC Run 9, the STAR FMS utilized a "cluster trigger". The trigger selected events that contained a highly localized, high energy deposition. The cluster size was sufficiently small that the trigger preferentially identified events with either a single high energy photon or a very close pair of photons from the decay of a high energy π^0. Higher mass objects, such as η mesons or jet-like events, could only satisfy the trigger when one of the associated photons had sufficient energy to pass the trigger requirements by itself. This led to quite low efficiency for such objects. Furthermore, for the case of the η meson, only very asymmetric $\eta \rightarrow \gamma\gamma$ decays were selected. The low-energy partner photon is often difficult to reconstruct, which reduced the efficiency even more. η meson decays constitute one of the largest backgrounds in measurements of the transverse single-spin asymmetry for direct photons. Direct photon transverse spin asymmetries are particularly interesting, because they can only arise from the Sivers effect. Thus, it is important to be able to measure η meson yields and asymmetries with good precision.

During Summer, 2010, we designed a new logic scheme for the FMS that replaces the cluster trigger with a combination of "jet patch" (JP) triggers. The JP layout is shown in Fig. 1. Each JP spans ¼ of the entire FMS. There are a total of eight JPs in order to provide significant overlap, thereby eliminating edge-effects in the trigger definition. Studies using PYTHIA events processed through an emulator of the new trigger, which we wrote, indicated that the JPs provide very high efficiency for high-mass objects like energetic η mesons and jet-like events. Nonetheless, we didn't want to depend solely on the JPs for triggering. Thus, the scheme also included a set of "board sum" (BS) triggers, which play
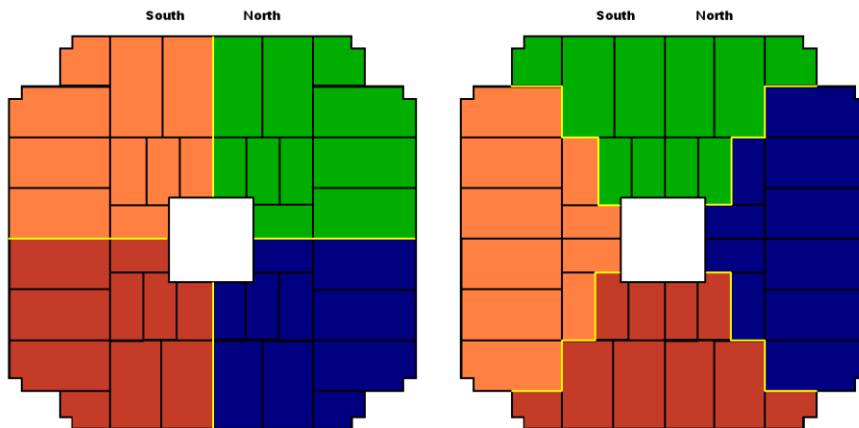

FIG. 1. View of the FMS from the STAR collision point, showing the eight overlapping jet patches.

a role analogous to the previous cluster trigger, plus high-tower (HT) triggers for calibration and low-level diagnostic purposes.

The new trigger logic required some recabling within the existing FMS trigger system, plus significant recoding of the trigger FPGAs. The effort required was deemed too large to complete prior to RHIC Run 11. Instead, a partial scheme that included four of the eight JPs, plus the full suite of BS and HT triggers, was installed and has been used during the run. The current plan is to implement the entire new trigger logic scheme before RHIC Run 12.