CERN-Japan fellowship report (2008)

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I started my fellowship in April 2006 as a member of the ATLAS trigger group. The first topic that I worked on was to develop a level-2 trigger algorithm to select cosmic-ray muons and to integrate the level-2 algorithm with the level-1 trigger and detector systems. As an outcome, I succeeded to run a level-2 algorithm online in situ for the very first time in early 2007. After this integration work, I focused more on preparing the trigger that we can use for the first data-taking, which includes various triggers for selecting physics and/or calibration events, commissioning purpose and triggers for monitoring and measuring efficiency of the primary selections. In ATLAS, the selection implemented in the trigger system as a whole, is called the trigger menu.

In 2008, I continued to work on the trigger menu development as my main activity. This work was done with various physics groups and trigger developers, and I have been responsible for the implementation and validation of the menu. We identified the physics requirements and optimized the menu within the constraints of the online system, in particular the bandwidth and processing power requirements. While working on the menu, I also developed software to configure the trigger system. This is essential for the work, as the configuration of the entire trigger, especially for the High Level Trigger (HLT), is quite large and complicated. Since we prepared the first version of a realistic trigger menu, which includes ~130 triggers at level-1 and ~180 at the HLT, it was used in various activities in the ATLAS collaboration, such as in simulation studies and tests of the real trigger and DAQ systems [1]. By running such large trigger menus with the real online system, we could measure the actual execution time and data flow rates at the HLT farms, and confirm that the menu is operational with the real system. Figure 1 shows the expected output rates of different types of triggers after the final stage of the selection, Event Filter (EF).

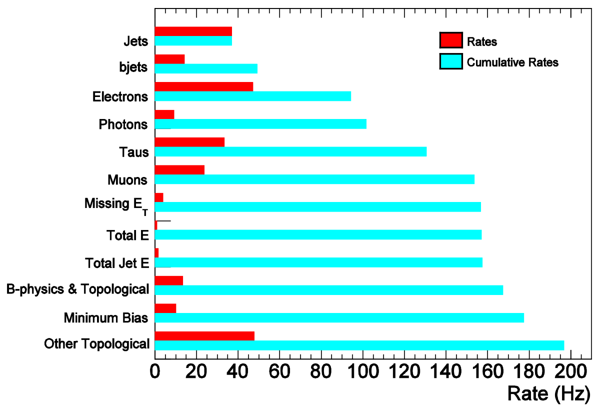

Figure 1: Output rates after the EF for different groups of triggers for the trigger menu at the luminosity of 10^{31} $cm^{-2}s^{-1}$.

On 10th September, the LHC delivered the first circulating beam. Our main goal was to trigger on activity related to the beam and to commission the level-1 trigger. In order to achieve this, we used the signal from a beam pick-up system (BPTX) to trigger the event when the beam arrives at ATLAS. The Minimum Bias Trigger Scintillator (MBTS) was also very useful to trigger on activities in the detector. During three days with beam, we collected useful data to investigate the relative timing of the input signals to the level-1 Central Trigger Processor (CTP). After the beam operation stopped, we prepared quickly the trigger for taking cosmic runs with the full ATLAS detector. The goal here was to collect as many track as possible traversing the inner detector volume. We collected around 7 million events triggered by the inner detector tracking algorithm which have been very important for commissioning the detector, and the calibration and alignment studies. I have been working as the trigger menu on-call expert during the data-taking.

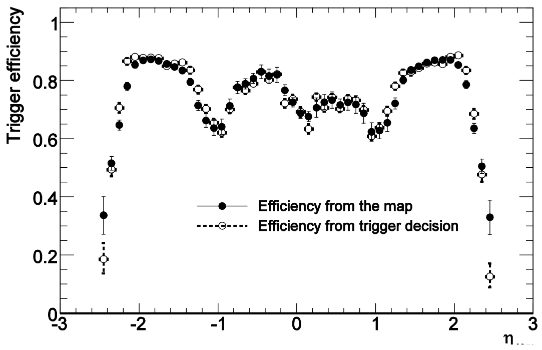

Figure 2: The level-1 efficiency to trigger on J/Ψ→μμ events as a function of η.

In addition to the development and operation of the trigger system, I am studying the muon trigger efficiency measurement using the J/Ψ→μμ sample. Due to the large cross section of J/Ψ production, this sample can be used at the early days of the experiment. We use J/Ψ→μμ events where two decay muons are reconstructed offline and require that at least one of the reconstructed muons was triggered. By investigating whether the second muon was also triggered or not, we can obtain the trigger efficiency directly from data. We have shown that with a few months of data-taking, we expect to measure the trigger efficiency with better than a few % precision. Also, we proposed a calibration trigger to collect the sample for such a study, namely to use a single-muon trigger at level-1 and apply a J/Ψ selection with loose requirement on the second muon in the level-2 trigger. This new trigger significantly increases the J/Ψ fraction in the triggered sample while keeping the bias low for the second muon. Figure 2 shows the level-1 trigger efficiency as a function of the pseudo-rapidity (η) of the J/Ψ. As can be seen, there is good agreement between the efficiency measured from the simulated data and that calculated with reference to the Monte Carlo "truth".

This study was conducted with two students where I coordinated the entire work of the group and wrote a note describing the work. This note will be part of the ATLAS-wide book on the expected performance of the ATLAS detector [3]. In future, I plan to extend this work further to study the inner-detector tracking performance using J/Ψ events.

It was a very exciting year to see the first beam and successfully be able to trigger on beam events, especially after having prepared for that moment for many months. In the near future, I'd like to work more on the analysis of early data for the understanding of the performance and for the measurement of the Standard Model processes.

Conferences and publication

1. T. Kono for the ATLAS Collaboration, The ATLAS trigger menu for early data-taking, 19th Hadron Collider Physics Symposium 2008, 27-31 May, 2008, Galena, Illinois, USA
2. The ATLAS Collaboration, The ATLAS Experiment at the CERN Large Hadron Collider, (2008) JINST **3** S08003
3. The ATLAS Collaboration, Expected performance of the ATLAS detector (to be published)