TRIUMF Summer Institute 2009

Analysis Methods at Hadron Colliders, Problem set #1

1. **Cross Section Measurement**: Consider two analyses using $\int \mathcal{L}dt = 10$ pb^{-1} that both measure the Z cross section at the LHC:

   - analysis A makes very tight cuts to reject as much background as possible. It determines to have an acceptance $\times$ efficiency of $10 \pm 0.5\%$. 2078 events are observed, and it estimates that there are 53 background events with an uncertainty of 50%.
   - analysis B makes looser cuts to increase the acceptance. It determines to have an acceptance $\times$ efficiency of $30 \pm 1\%$. 6712 events are observed. Due to the looser cuts it has a lot more background: it estimates that there are 635 background events, and also claims an uncertainty of 50% on this number.

   Both analyses known the luminosity to a precision of 3%.

   (a) Determine the cross section for analyses A and B

   (b) Determine the relative uncertainty on the cross section for both cases. What is the dominant component of the uncertatinty in the two cases?

   (c) Which analysis achieves the higher precision? How does this change if $\int \mathcal{L}dt = 1$ pb^{-1} or $\int \mathcal{L}dt = 100$ pb^{-1} assuming the relative uncertainties on the acceptance, background and luminosity stay the same.

2. **Trigger Efficiency Measurement**: You want to measure the electron trigger efficiency for the `ele20` trigger using the "tag-and-probe" method. The `ele20` trigger requires an electromagnetic object > 10 GeV at Level1, a track with $p_T > 10$ GeV/c matched to it at Level2 and a 20 GeV electron object with a 10 GeV track at L3. For this purpose you select a clean Z sample by selecting two high pt electrons (passing the same cuts as your analysis). Assume the selected sample is free of background.

   You observe the following

   - here are 257 Z candidates passing your selection and the `ele20` trigger
   - in all 257 of the events there is at least one trigger electron that passed all three trigger levels but in 203 of the events there are two trigger electrons.

   Determine

   (a) What is the single-electron trigger efficiency to trigger an electron with your selection cuts?

   (b) What is the efficiency of the `ele20` trigger to trigger a Z with your selection cuts?