Work programme

The next five years will see the first phase of LHC exploitation. It is quite likely that research priorities will change over that period, which may condition the program set out below. In such case, I believe the direction of my research programme should adapt to the changing scene.

The proposed programme is essentially to pursue research in particle physics using the ATLAS detector. The ATLAS high-level trigger, where I have developed much of my work for the past four years, will initially be a strong component of the intended programme. The main focus of the work, however, will soon become the new physics that can be accessed with this experiment.

One of the main tasks in the LHC experiments for the next one to two years will be to understand the LHC environment and the response of the detectors and trigger systems. During the 2008 run, ATLAS is expected to accumulate a few tens of pb^{-1} of data at $\sqrt{s}$ = 10 TeV. The ATLAS high-level trigger is going to be operated in pass-through mode for much of this run. This data will be precious for debugging the trigger code and finding where the weaknesses of the system lie. As trigger software validation coordinator, I will be in a privileged position to contribute to the improvement of the trigger code.

Measurements of well-known Standard Model processes will be a fundamental basis to the discovery of new physics. One of the essential steps in this process will be the observation of top-quark pair production. It is expected that an integrated luminosity of 100 pb^{-1} will be sufficient to determine the top-pair production with less than 10% uncertainty. I propose to contribute to this analysis. Possible areas of contribution would be studies of the trigger efficiency in the busy environment of top-pair events, or the study of the b-jet energy scale from dijet samples containing non-isolated muons. This activity would allow me to increase my contribution to the data analysis activity and become a strong contributor to physics publications. The experience gained in top-quark reconstruction using the ATLAS detector would be invaluable for other physics studies.

The primary aim of the LHC is to study electroweak symmetry breaking, and so to search for the Higgs boson. In the minimal Higgs sector of the Standard Model, there is one Higgs boson, whose only free parameter is its mass, m_H. Current analyses of precision data favour a light Higgs boson, between the LEP limit of 114.4 GeV and around 190 GeV. Recent results from the Tevatron experiments have excluded a mass point at 170 GeV (fig.1). It seems likely that the Tevatron experiments will be able to exclude more of the mass region around $2m_W$, if the Higgs doesn't exist in this region. On the other hand, a combination of ATLAS analyses showed recently that significant integrated luminosity, above 25 fb^{-1}, will be needed to probe the region down to m_H = 115 GeV (fig.2). All this reinforces the need for more analyses focussing on the low m_H domain. I propose to contribute to the search for the Higgs boson produced in the ttH channel with Higgs boson decaying to a b-quark pair. This channel, not included in the results shown in figure 2, has it's best sensitivity at low mass. This is a challenging analysis, but if successful, and with increased luminosity, it would allow the determination of the Higgs Yukawa coupling to the top quark.

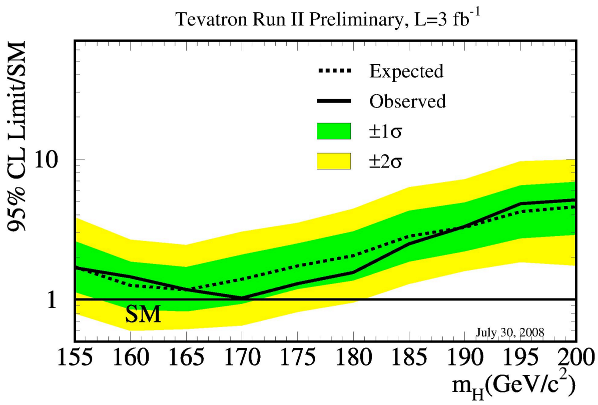

Figure 1: Higgs exclusion at 95% confidence level from the Tevatron experiments, plotted versus the Higgs boson mass.

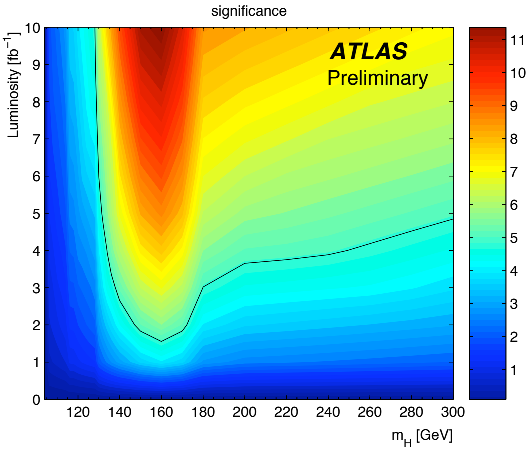

Figure 2: Integrated luminosity needed in for discovering the Higgs boson in ATLAS, plotted versus the Higgs boson mass. The solid line represents the 5σ discovery contour.

The timeline of this work programme is as follows:

1. Contribute to the establishment of the stable running of the ATLAS trigger through my role as trigger software validation coordinator until the end of the 2008 run. Use the lessons learned during this period to promote and implement improvements in the software;

2. Simultaneously with the previous item, contribute to the initial analysis of top-quark production in ATLAS. This should establish the observation of top events sometime in 2009 and result in a publication. This strand of the intended work can be expected to last until 2010;

3. In parallel with the previous item, contribute to the development of the searches for a light Higgs boson in the production ttH production channel. The experience gained in the reconstruction of top quarks should be important in this domain.