Statement of Research Interests for Marcos Jimenez, March 2008

The principal goal of the LHC is to explore a new energy scale and see what predictions hold true and (more importantly) what unpredicted physics may lie there. For example, the way in which the electroweak sector is spontaneously broken, the Higgs Mechanism, is a cornerstone of the Standard Model (SM) that has yet to be experimentally verified. Thus, the mechanism whereby particles acquire mass remains unknown. However, if the SM is a true effective theory of nature at low energy scales, as we believe it to be, then the Higgs particle ought to be lurking at the energy range made accessible by the LHC, the TeV scale. Shedding light on this corner of the SM makes the LHC project extremely attractive.

As is well known, the gluon fusion Higgs production channel decaying leptonically could provide the cleanest signal for the Higgs. However, before this or any other new physics can be detected the detector itself has to be properly understood. One way to do this is to use known SM processes to calibrate the detectors and estimate their resolution. More generally, it will be necessary for the SM to be re-discovered at the LHC detectors before new physics observation can be claimed. In fact QCD, with which I am particularly familiar from these past four years of research with the ZEUS Collaboration at HERA, will constitute an important background to many new physics searches.

I think a particularly interesting venue of research which I can immediately delve into during the early operation of the LHC is Z production. The Z can decay into two charged leptons so it is easy to spot. The very precise knowledge of the Z boson mass (to about 2 MeV) makes it possible to use this particle as a probe of the absolute detector energy scale (from the Z peak) and its resolution (from the Z signal width). Moreover it will familiarize me with charged lepton search and recognition.

Another attractive early venue of research is top production. Since top quark pairs will be produced abundantly this venue provides a good calibration tool. Moreover, it involves high level objects such as b-quark jets, isolated leptons, missing energy and jets from W-boson decays. It will be rewarding to familiarize oneself with these objects early on, since they are key ingredients for the next stage of analyses, those of new physics searches. A good channel to identify top production is $t\bar{t} \to WbWb \to (l\nu)b(jj)b$. The fully leptonic decay is difficult to recognize due to neutrino missing energy while the fully hadronic decay suffers from background. Although the semi-leptonic channel is the cleanest, it involves the non-trivial recognition of b-jets. If we look at the Tevatron for help, we find that a b-tagging algorithm based on secondary vertices provides a solution. Nevertheless, such an algorithm could take time to develop at the LHC. In the meantime, a b-jet sample can nonetheless be selected if the main background to this channel ($W + jets$) is well understood and proper cuts are applied. [1] Once the sample is selected, the non-b jets should match the W mass, providing a good calibration tool through the peak and the width of the resonance as with the Z.

Both Z and top production measurements are attractive analyses for the early operation of the LHC to which I would like to contribute. They are valuable in their own right, but perhaps more appealing is that they will be rewarding later, once searches for new physics become possible, including Higgs signal searches.

[1] I. Van Vulpen,Acta Phys. Polon. B **38** (2007) 515.