Research statements

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During my Ph.D. work at the Deutsches Electronen-Synchrotron with the CMS experiment at the Large Hadron Collider (LHC), I have witnessed one of the world's most complex scientific undertakings during its final construction, commissioning, operation, and announce of its first discovery. It has been an exciting time.

The Compact Muon Solenoid (CMS) [1] is one of the two general purpose detectors at the LHC. CMS was built to detect the products of the proton-proton collisions with high energies of tens TeV. The LHC had a tremendous success last years. Besides many important measurements of the standard model (SM) physics and a wide spectrum of searches for new physics beyond the SM, a very important and exciting discovery of a new boson with mass of 125 GeV has been recently made [2]. Measuring the properties of the Higgs boson could be the first step verifing the Higgs mechanism to break the electroweak symmetry of SM. An important study that would allow to understand the properties of the newly discovered boson is a measurement of the coupling strength between the boson and third-generation SM particles: top,bottom quarks and tau lepton. A precise study of decays $H \to \tau\tau$ and $H \to b\bar{b}$ would play a crucial test of the Higgs mechanism in the SM or in the theories beyond it.

Even after a great experimental success, the SM suffers from some theoretical problems such as: instability of the Higgs boson mass against radiative correction, hierarchy of the fundamental scales, hierarchy in the masses of fermions, mechanism to break the electroweak symmetry, mechanism of CP violation etc. Some or all of these problems are addressed in various models of physics beyond the SM, such as models with extra-dimensions, with supersymmetry, or with other additional symmetries. Each of these model invariably propose new heavy particles that can potentially be produced at the LHC.

I am interested in pursing physics involving the Higgs coupling with the third-generation SM particles like top,bottom quarks and tau lepton. I am confidient that my extensive research experience allows me significantly contribute in these efforts. I already play an important role in studying the Higgs physics with b jets, which I perform within my doctoral scholarships in DESY CMS Higgs group. This activity is complement by my expertise of the online procedure, the High Level Trigger [3], filtering multi-jet events in the CMS detector. I am one of the primary authors of the search for the neutral Higgs boson decaying to pair of $b\bar{b}$ quarks in association with b-quark performed at 7 TeV data. The analysis covers the neutral Higgs sector in minimal SUSY scenarios [4]. One of my primary contributions was a Monte Carlo study of the signal and background kinematics to optimize the offline pre-selection criteria used in the analysis. This yields an sensitivity improvement of the search potential

in this challenging channel. I have developed the method of multivariate analysis to optimize the Higgs search procedure in a unbiased way. I have further expanded my research experience investigating the estimations of effects from the systematic uncertainties related to the analysis. I have played the main role in obtaining the final results, developing a fitting procedure used to extract the observed cross section of the Higgs boson production. Using statistical procedures, I have performed the calculation of the exclusion limits on the parameters in the Supersymmetric theory.

The large hadronic interaction rate at the LHC poses a great challenge for triggering the events with signature of three b jets in the final state. A significant reduction of the rates with preserving the signal efficiency is achieved with b-jet identification algorithms (b-tagging) applied at the HLT.

To ensure high efficient performance of b-tagging at the HLT, I serve as one of the active developers of such algorithms in the CMS Trigger Study Group. In particular, one of my primary responsibility is to superviese and control such efforts in the online b-tagging optimization. All improvements of b-jet tagging at the HLT are important not only for the Hbb production process but also for boosted Higgs, and a number of beyond SM searches that have b jets in the final state. The current upgrade of the b-tagging HLT will guaranty that the CMS detector performance and data analysis methods are optimal for the high-intensity, high pileup environment of the next LHC run at the centre-of-mass energy of 14 TeV.

Due to my experience , I have in the $bH \rightarrow 3b$ search and in b-jet identification, there is an obvious opportunity for me to bring my ideas to the PUT_NAME_OF_UNI [5] and its efforts with the CMS experiment.

The first task in any collider data analysis, and especially in the search for new physics, is to ensure that the relevant collisions are recorded for later analyses. During the first half of the fellowship, I propose to continue to develop my current work within the CMS trigger. My position as trigger software validation co-coordinator will allow me to use the lessons learned from the collected data in 2012 (2011) to identify the directions for the software upgrade during the current long shutdown. The strong trigger involvement of the PUT_NAME_OF_UNI [5] would make it an ideal place to develop this activity. I plan to clarify the strategic trigger needs of the Higgs analyses in 2014. In addition to that, the set of the control triggers will be added to estimate efficiencies of the Higgs triggers in the unbiased way.

The second half of the fellowship will correspond to a period when the LHC will run with high luminosity at 14 TeV energy. During this period, I propose to contribute to measurements of production cross section for $b\bar{b}H$ and $t\bar{t}H$. This analysis will rely on the triggers with btagging for which the efficiencies are estimated from the previous step of the fellowship. My experience of the trigger software will be hugely valuable me in this task.

After obtaining the first measurement of the production cross section, the $H \rightarrow b\bar{b}$ and $H \rightarrow \tau\bar{\tau}$ would be ideal observable channels of the Higgs boson coupling to the third-generation fermions. The next step will be to measure such couplings of the Higgs boson candidate, and so to verify whether it corresponds to the SM prediction, or if it is part of a more complex scenario. The LHC Higgs Cross Section Working Group has recently published recommendations for the parametrization of measurements to explore the couplings of this new Higgs-like state [6]. For example, it can be achived by observing the Higgs in the channels, and the ratios of Higgs production cross sections in these channels.

If the evidence for a Higgs boson in the

$$t\bar{t}H,\ b\bar{b}H,\ H \to \tau\bar{\tau}, b\bar{b}$$

would be found, I intend to measure its CP quantum number [7]. The observation of a CP-odd Higgs candidate, would exclude the SM Higgs, which is CP-even. If the studying the properties of the Higgs sector would demonstrate that the current Higgs excess is not SM-like, it would offer the first convincing evidence of supersymmetry. The observables of CP quantum number involve the polarization and/or spin correlation of the decay products of the Higgs boson and the associated heavy flavour, top or bottom, quark(s). The polarization observables are strongly related to the azimuthal distribution of secondary lepton from decay of the top quark or the Higgs boson. The polarization of the produced particles are usually studied by means of kinematical distributions.

While the outlined research activity to measure the Higgs properties would likely take a few years, I also would like to get engaged in the CMS upgrade activity to extend my research experience. It is very important to have a hands-on experience with the hardware which helps me to efficiently participate in the CMS detector operation during the upcoming LHC runs in 2014.

In summary, I would be enthusiastic to contribute to any efforts to measure all of the couplings of the new resonance. My strong experience of the CMS HLT and data analysis tools, my knowledge and publications in wide variety of topics covering the theoretical and experimental physics aspects makes me well-prepared to tackle the very exciting investigation of the electroweak symmetry breaking and its origin in the LHC data. Working in such a prestigious laboratory with a team of brilliant and motivated people is a huge opportunity. A post-doctoral position at PUT_NAME_OF_UNI [5] is an excellent match for my research, As a post-doctoral researcher, I will endeavor to distribute an atmosphere where knowledge and experience are easily shared among collaborators, and to continue to take initiative in leading projects.

[1] ref1
[2] ref2
[3] ref3
[4] ref4
[5] ref5
[6] ref6
[7] ref7

Appendix

How to generate the document

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