REPORT

CARLOTTA FAVARO

My main project within the CMS group of CEA/Saclay consists in the analysis of LHC proton-proton collision data aimed at determining the properties of the Higgs boson, namely its couplings and quantum numbers. The analysis exploits the production mechanism known as vector boson fusion (VBF), which allows to probe the coupling of the Higgs boson to the $W^{\pm}$ and Z^0 gauge bosons (HVV). The subsequent decay of the boson into a photon pair is chosen. The experimental signature is constituted by two well-reconstructed and isolated photons with high transverse momentum, in association with two forward jets with high invariant mass. The main backgrounds are the QCD production of photon pairs, and the Higgs production through gluon fusion, which doesn't provide access to the HVV coupling. Events are sorted into several categories, defined according to the expected signal to background ratio.

The kinematics of the two jets and of the photon pair, as well as the angular correlations, has to be used to disentangle the signal and background contributions and to extract information about the boson parity and about the structure of the HVV coupling. In detail, we developed a method based on a simultaneous maximum likelihood fit of the invariant mass of the photon pair and of the angle between the two tagging jets in the azimuthal plane, which was proved to be the variable with the best discriminating power in this context. The fit is applied to the event categories with the highest signal-to-background ratio. In order to improve the capability to distinguish between anomalous HVV coupling scenarios and the standard model gluon fusion contribution, which are characterized by similar angular distributions, we also apply the so-called Matrix Element Likelihood Analysis (MELA) approach. It constructs a discriminant consisting of the ratio between the probabilities of the two processes, evaluated with the matrix element calculation techniques, allowing to exploit the full kinematic information.

In the last months I dedicated myself to developing the software framework for the analysis, and to the synchronization of the results with the ones independently obtained by other groups within the CMS collaboration.

Before analyzing the data, the dynamics of the signal and background physics processes has to be studied using the Monte Carlo simulation. For the associated production of a Higgs boson and two jets we use the JHU generator, which is able to

properly describe anomalous HVV couplings. In this context, I took part in the production and testing of the generated event samples.

Although the release of a preliminary result is expected based on the LHC collision data at center-of-mass energies of 7 TeV and 8 TeV, collected by CMS in 2011 and 2012, the final measurement will be performed with the larger data samples expected for the LHC run II, at a center-of mass energy of 13 TeV. The running conditions will be different from the past run, and more challenging, due to a higher number of multiple proton-proton interactions per bunch crossing (pile-up interactions). A significant effort therefore has to be made to adapt the particle-reconstruction algorithms and consequently the analysis strategy to be ready for the data taking. I am currently contributing to the development of a new common software framework that will be used for all the analyses related to a Higgs boson decaying into a photon pair. I am also taking part in the studies for the validation and the evaluation of the performance of a new photon identification method. It uses an improved local reconstruction algorithm, aimed at mitigating the effect of the higher number of pile-up interactions, and combines the information from the different CMS sub detectors.

I am also involved in the commissioning and operations of the CMS electromagnetic calorimeter (ECAL). Since August 2014 I am coordinator of the ECAL Prompt Feedback Group, which provides a link between the commissioning and data acquisition teams and the physics analysis groups. I am in charge of providing quick feedback about data properties, of developing and maintaining the related software tools, and I'm responsible of the certification of the LHC collision data for physics analysis.

Publications

[1] The CMS Collaboration, "Observation of the diphoton decay of the Higgs boson and measurement of its properties", *submitted to Eur. Phys. J. C.*, `arXiv:1407.0558v1`