Flavor Independent Search for Neutral Higgs Bosons

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Within the minimal supersymmetric extension of the standard model (MSSM) [1] two scalar Higgs field doublets are introduced. These give rise to five physical Higgs Bosons: a charged scalar pair ($H^{\pm}$), two neutral CP-even scalars (h and H with $M_h < M_H$) and a neutral CP-odd scalar A. At present LEP2 energies there are two predominant production mechanisms of neutral Higgs particles: The Higgsstrahlung process and the associated pair production (fig. 1).

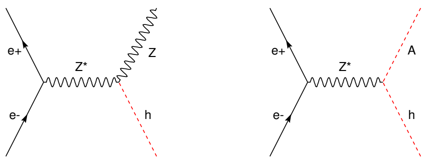

Fig. 1: Lefthand side: Higgsstrahlung process: The Higgs Boson is radiated off the virtual Z-boson line. Righthand side: associated pair production: The production of hA is mediated by a Z-boson in the s-channel

The production cross sections for both the processes [2] are complementary in the sense that at tree level the first is proportional to $\sin^2(\beta - \alpha)$ while the second is proportional to $\cos^2(\beta - \alpha)$. Here α is the mixing angle of the CP-even fields and $\tan\beta$ is the ratio of the two vacuum expectation values of the Higgs fields.

We perform a search for the neutral Higgs bosons produced via associated pair-production with data taken at the OPAL experiment at LEP. The main decay modes are $h, A \rightarrow b\overline{b}, c\overline{c}, \tau\overline{\tau}, gg, \gamma\gamma, W^*W^*, Z^*Z^*, Z\gamma$ and $h \rightarrow AA$ when it is kinematically accessible. We focus on fully hadronic decays where each boson leads to a pair of hadron jets giving four jets in the final state. Since the regions of the parameter space where the Higgs boson decay is dominated by the $b\overline{b}$ mode is already fairly covered [3], we rather concentrate on the regions where the branching ratio to $c\overline{c}$ is enhanced while the one to $b\overline{b}$ is suppressed. This occurs mainly for low $\tan\beta$. To gain sensitivity in the interested parameter space, an analysis without b-quark tag is necessary. To distinguish the signal from the background a likelihood technique based on kinematics and event shape related variables is used. As we make no use of b-quark tagging specific observables the background from W^+W^- or Z Z production is dominant and especially critical in the region $M_A \simeq M_h \simeq M_W$ or M_Z.

Presently we are implementing a constrained fit in our analysis which will provide one of the input variables for the likelihood discriminator. The kinematic fit allows to vary the measured 4-vectors of the jets within the estimated errors, to fulfill energy and momentum conservation. Additionally the two dijet-masses are constrained to yield to a certain mass difference.

An important input to this fit is the resolution on the measured jet quantities. This is estimated using Monte Carlo generated events, and it is defined as the difference between the 4-vector components of the jets, obtained after a full simulation of the OPAL detector response, and the generated 4-vector components of the initial quarks.

The resolution is found to depend on a set of measurable variables such as the energy of the jet itself, the angle of a jet to the beam pipe, the position of the jet with respect to the other jets in the events and the resolution parameter (Y_{cut}) of the jet finder algorithm used to resolve the jets. The resolution is therefore parametrised as a function of these variables. The obtained parameterisation is used to estimate on an event-by-event basis the errors on jet quantities for real data.

The average jet energy resolution obtained for the generated process $e^+e^- \rightarrow Z \rightarrow hA \rightarrow c\overline{c}\ c\overline{c}$ is 10%, the resolution of the angle between the obtained jets and the initial partons is 3° (fig. 2). This will be enhanced after the full constrained kinematic fit is applied as well as with the choice of a more suitable jet-finding algorithm.

After the energy momentum conservation constraint, we achieve a mass resolution on M_h and M_A of σ_M better than 3 GeV for generated masses between 30 and 100 GeV. Besides the output of the constrained kinematic fit with tuned errors we study additional variables as input to the likelihood discriminator. The whole analysis is expected to have enough sensitivity to exclude a sizeable region in the MSSM parameter space.

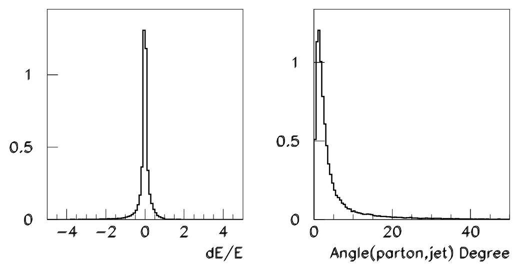

Fig. 2: Energy and angular resolution

References

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