More on the Model Independent Measurement of BR(h→BSM) & the Systematic Error from ΔBR(h→BSM) on SM σxBR Measurements

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Oct 27, 2016

Perform searches for *N* different $h \to BSM$ decay channels.

A search for one of these channels might involve more than one decay topology -- for example, if the decay channel is $h \to \phi_1 \varphi_2$, where ϕ_1 & φ_2 are neutral scalars, then there could be several decay topologies depending on how ϕ_1 & φ_2 decay.

To cover all possible decay channels involving new undiscovered particles it is probably sufficient to consider neutral particles only since charged particles would have been discovered in the LEP2, LEP e^+e^- colliders , and at lower energy e^+e^- colliders.

Higher mass resonances would induce Effective Field Theory (EFT) four point vertices such as $h\gamma f\bar{f}$ $h\gamma W^+W^{-*}$ $hZf\bar{f}$ and so on. An EFT analysis could help limit the possibilites

The 95% CL limit on BR($h \to BSM$) would be given by

$$\max_i \left\{ 95\%\ \text{CL limit for BR}(h \to \text{BSM decay channel } i) \right\}$$

Systematic Error on $\sigma \bullet BR_i$ from ΔBR_{BSM} (no specific $h \to BSM$ analyses)

Neglecting non-Higgs background, the number of events N_i passing Higgs decay channel i selection criteria is

$$N_i = \sum_j \sigma \bullet BR_j \, \varepsilon_{ij} \, L$$

ε_{ij} = efficiency for Higgs decay mode j to pass Higgs decay channel i selection

For SM decays the efficiencies ε_{ij} can be calculated with MC. But what if decay mode j is a BSM decay? To account for this possibility a conservative systematic error can be assigned assuming $\varepsilon_{ij} = 1$. This leads to a systematic error of $\Delta N_i = L\sigma \, \Delta BR_{BSM}$

Systematic Error on $\sigma \bullet BR_i$ from ΔBR_{BSM} (with N specific $h \rightarrow BSM$ analyses)

Neglecting non-Higgs background, the number of events $\boldsymbol{N_i}$ passing Higgs decay channel $\boldsymbol{i}$ selection criteria is

$$\boldsymbol{N_i = \sum_j \sigma \bullet BR_j\, \varepsilon_{ij}\, L}$$

$\boldsymbol{\varepsilon_{ij}}$ = efficiency for Higgs decay mode $\boldsymbol{j}$ to pass Higgs decay channel $\boldsymbol{i}$ selection

For SM decays the efficiencies $\boldsymbol{\varepsilon_{ij}}$ can be calculated with MC. If we have analyzed $\boldsymbol{N}$ different $\boldsymbol{h \rightarrow BSM}$ decay channels then these channels can be included in the analysis of the $\boldsymbol{SM}$ decay channels. This should help improve the limits on the $\boldsymbol{h \rightarrow BSM}$ decay channels, and systematic errors from possible BSM decays -- having been included in this manner in the $\boldsymbol{SM}$ analysis -- don't have to be included in the systematic error budget.