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Search for non-SM Light Higgs Boson in the $h \to \gamma\gamma$ Channel at DØ in Run II

ALEX MELNITCHOUK*

Department of Physics and Astronomy,
The University of Mississippi,
108 Lewis Hall, P.O. Box 1848
University, MS 38677-1848

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A search for non-SM light Higgs boson with an enhanced branching fraction into photons in $p\bar{p}$ collisions at the Fermilab Tevatron is presented using Run II DØ data taken between April 2002 and September 2003. We set 95% CL limits on the diphoton branching fraction as a function of Higgs mass for Fermiophobic and Topcolor Higgs scenarios.

Keywords: Higgs; fermiophobic; photon.

1. Motivation

$\gamma\gamma$ is a very clean signature which makes it promising and important especially for the hadron collider environment. There are many extensions of the SM that allow enhanced $\gamma\gamma$ decay rate of the Higgs largely due to suppressed couplings with fermions [1]. We consider Fermiophobic Higgs (no Higgs-fermion couplings) and Topcolor Higgs (coupling with the top quark is allowed)

2. Dataset

We used the data collected by the DØ detector between April 2002 and September 2003. The integrated luminosity of this sample is $191.0 \pm 12.4\,\mathrm{pb}^{-1}$ Trigger selection was done with high p_T di-EM[a] trigger. Offline we require two reconstructed photon objects in the good η fiducial region ($|\eta| < 1.05$, $1.5 < |\eta| < 2.4$) with $p_T > 25\,\mathrm{GeV}$. We require that the p_T of the diphoton system is above 35 GeV [2].

3. Backgrounds

Major sources of background to $h \to \gamma\gamma$ are $Z/\gamma^* \to ee$, direct diphotons, $\gamma + jet$, and multijet QCD processes.

*Fermilab, MS#352, Batavia, IL, 60510, USA.
[a]EM stands for "electromagnetic object", i.e. electron or photon

4. Results

The $\gamma\gamma$ invariant mass distributions for the data and predicted background, as well as the event yields are shown in Fig. 1. Figure 2 shows 95% CL limits on the B($h \to \gamma\gamma$) as a function of Higgs mass. Comparison is made with DØ Run I and LEP results as well as Run II Monte Carlo studies for Tevatron [5].

5. Conclusions

A search for non-SM light Higgs boson with an enhanced branching fraction into photons was performed using 191 pb^{-1} of data collected by the DØ experiment in Run II of the Fermilab Tevatron. We set 95% CL limits on the diphoton branching fraction as a function of Higgs mass for Fermiophobic and Topcolor Higgs scenarios. Our current sensitivity is comparable with Run I.

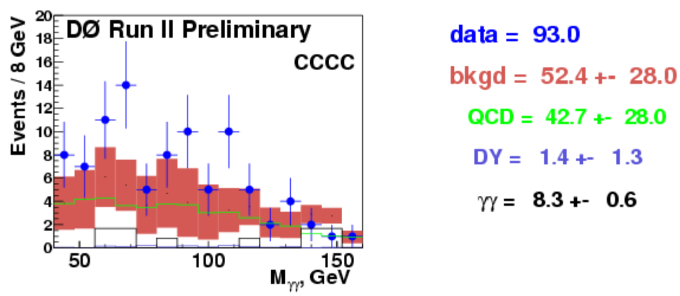

Fig. 1. $\gamma\gamma$ invariant mass distributions and event counts for different event topologies with new photon ID after analysis optimization cut ($p_T^{\gamma\gamma} > 35$GeV) is applied. Points – $\gamma\gamma$ spectrum observed in data, red rectangles – total SM background with errors, green line – QCD background, brown line – Drell-Yan background, black line – direct diphoton background.

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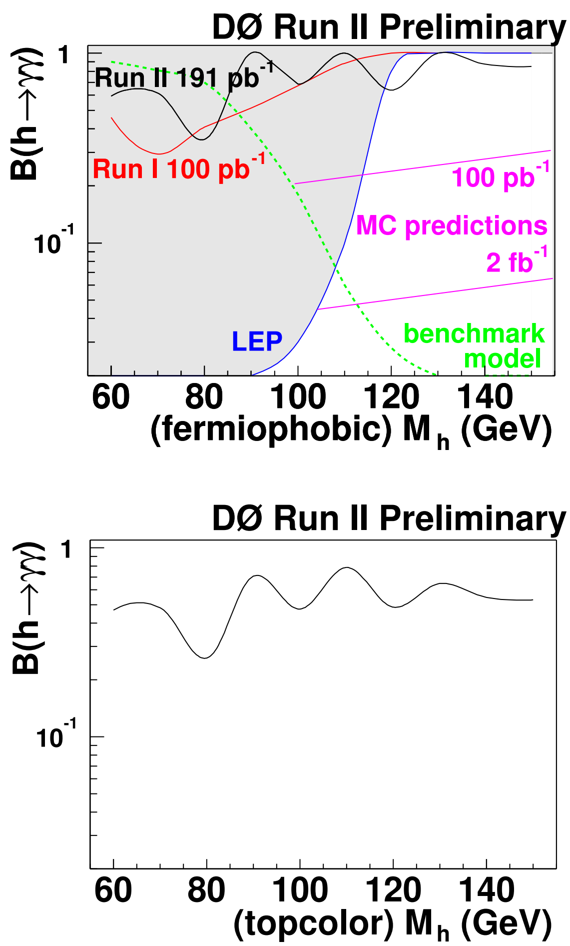

Fig. 2. 95 % CL limits on the Higgs decay branching fraction into photons as a function of mass (black curve). Top plot – fermiophobic Higgs scenario, bottom plot – topcolor Higgs scenario. On the top plot exclusion contours from DØ Run I [3] (red) and LEP [4] (blue) are overlaid. Magenta lines show $100\,\mathrm{pb}^{-1}$ and $2\,\mathrm{fb}^{-1}$ Monte Carlo predictions for Tevatron Run II [5] based on Run I DØ and CDF efficiencies and misID rates. Green points – theoretical curve for benchmark fermiophobic Higgs model [4].

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