DIRECT PHOTON PLUS JET STUDY FOR THE CMS EXPERIMENT*

P. Gupta, B.C. Choudhary, S. Chatterji, S. Bhattacharya
R.K. Shivpuri

University of Delhi, Delhi-110007, India

(Received November 29, 2007)

We present simulation results of γ + jet analysis using CMS (Compact Muon Solenoid) object-oriented software at the Large Hadron Collider (LHC) center of mass energy $\sqrt{s} = 14$ TeV. Optimization of isolation cuts for direct photon and topology based study improves the signal over background ratio by $\sim 42\%$ as compared to previous studies done in CMS.

PACS numbers: 12.38.–t, 14.70.Bh

1. Introduction

Prompt photon production in hadronic interactions provides a test of pQCD and a constraint on parton distribution functions (PDFs) of the hadrons. The two leading order (LO) processes which contribute to $\gamma +$ jet events are "Quark–Antiquark Annihilation" and "Quark–Gluon Compton Scattering". The background consists of events where a jet fragments in such a way that a single neutral particle carries most of the momentum of the parent parton which decays into photons and from photons produced in initial and final state radiations. The purpose of this work is to study the $\gamma+$jet events and its background processes with full detector simulation and reconstruction, and optimize the signal/background (S/B) ratio at the LHC energy.

2. Analysis and results

In the analysis, we require that the leading photon should have $P_{\mathrm{T}}^{\gamma} > 80$ GeV and $|\eta^{\gamma}| < 2.6$. We observe that a better reduction in the background rate can be achieved by combining isolation requirements (for details see [1]) from various detectors (Tracker + ECAL + HCAL). Some

* Presented at the Symposium "Physics in Collision", Annecy, France, June 26–29, 2007.

combinations which are found to yield better S/B ratio are shown in Table I. In comparison to selection A (used in CMS Physics TDR-I [2]), selection C provides a further reduction in background by $\sim 22\%$, thus giving a $\sim 26\%$ increase in the S/B ratio. Fig. 1 shows the number of events/GeV for 1 fb^{-1} of integrated luminosity calculated as a function of P_{T}^{γ} for the γ + jet signal and its background after selection cut C. Fig. 2 shows the predictions for the differential cross-section of the γ + 1 jet events as a function of P_{T}^{γ} which have been compared with theoretical LO and NLO calculations [3]. The results are found to be in agreement with the theoretical LO calculations. For all cases discussed in Table I requiring $\Delta\phi > 140^{\circ}$ between photon and jet further improves the S/B ratio by $\sim$ 15–17% with almost no loss in signal efficiency, thus leading to an overall gain of $\sim 42\%$ in S/B ratio.

TABLE I

Selection cuts and corresponding signal efficiency, signal and background rates, and S/B ratio for low luminosity ($\mathcal{L} = 2 \times 10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$) at $\sqrt{s} = 14$ TeV.

Selection Cut	Cone Size R R	$P_{\mathrm{T}}^{\mathrm{Thres}}$ (GeV)	$E_{\mathrm{TECAL}}^{\mathrm{Thres}}$ (GeV)	$E_{\mathrm{THCAL}}^{\mathrm{Thres}}$ (in Barrel) (GeV)	$E_{\mathrm{THCAL}}^{\mathrm{Thres}}$ (in Endcaps) (GeV)	Signal Efficiency	Signal Rate (Hz)	Background Rate (Hz)	S/B Ratio
A	0.3	1.5	1.5	6.0	4.0	0.76	2.12	1.40	1.52
B	0.3	1.0	1.5	6.0	5.0	0.76	2.10	1.26	1.66
C	**0.4**	**1.5**	**2.0**	**7.0**	**5.0**	**0.74**	**2.09**	**1.09**	**1.92**
D	0.4	1.5	2.0	6.5	5.0	0.73	2.07	1.06	1.94
E	0.5	1.5	2.5	8.0	6.0	0.70	1.99	0.84	2.37

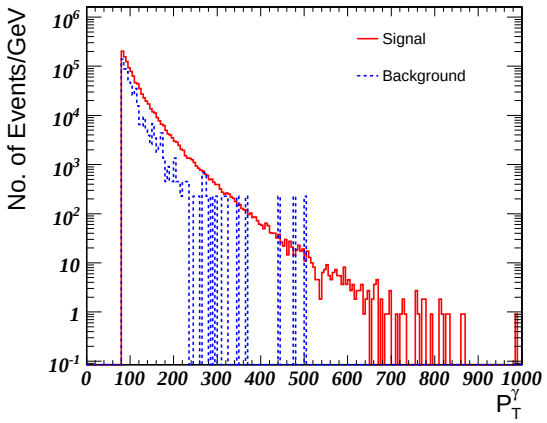

Fig. 1. Number of events/GeV for γ + jet signal and its backgrounds for $\int \mathcal{L}dt =$ 1 fb^{-1} after applying selection cut C.

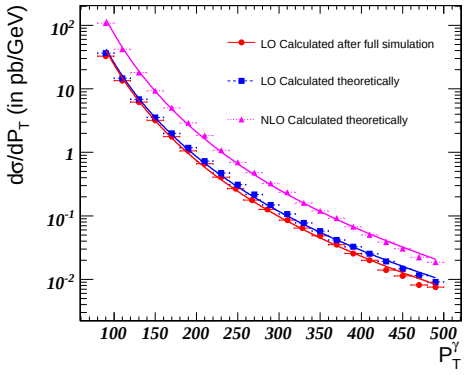

Fig. 2. The LO (after full simulation) and theoretical LO and NLO calculations for the cross-section of γ + jet events as a function of P_{T}^{γ}.

REFERENCES

[1] P. Gupta *et al.*, CMS NOTE-2007/004, [arXiv:0705.2740v3 [hep-ex]].
[2] CMS Collaboration, CERN/LHCC 2006-001.
[3] J. Owens, private communications.