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The background to the "$\gamma + jet$" channel at low luminosity in CMS detector.

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Abstract

We investigate the possibility to suppress background to the $\gamma + jet$ channel using the cuts on the various measured variables in the condition of low luminosity pile-up $2 \cdot 10^{33} cm^{-2} s^{-1}$. The estimation of the background and systematic errors due-to background are presented.

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1 Introduction.

The possibility of the calibration of CMS calorimeters with $\gamma + jet$ channel is determined by as far as it is possible to separate these events from the background ones. The possibility of suppression of background to $\gamma + jet$ events with reference to CMS setup was investigated in [1] - [2] earlier. Meanwhile the recent investigations were performed on particle level or with fast monte-carlo and did not take into account detector effects so as pile-up in detail which essentially can affect the calibration.

Now we consider the $\gamma+jet$ channel with detailed simulation of the CMS setup at low luminosity ($2{\cdot}10^{33} cm^{-2}s^{-1}$). Program packages PYTHIA 6.156 [3], CMSJET 4.703 [4], CMSIM 121 [5] and ORCA 4.5.4 [6] are used for calculations. The estimation of both the number of background events and the errors which contribute to the calibration of jet energy are presented.

2 The simulation and the preliminary selection of the events.

The dijet events in which either the photons from the radiation ("$\gamma - brem$"), or the photons from the mesons decays ("$\gamma - mes$") might carry the large energy and be recognizable in the calorimeter as the direct photons are indistinguishable in setup from $\gamma + jet$ events.

Further we will apply to the events as "$\gamma - dir$" (from $\gamma + jet$), "$\gamma - brem$" and "$\gamma - mes$" (from dijet events).

The generation of the events is carried out with PYTHIA 6.156. All processes with direct photons (ISUB=14, 29) QCD and standard model with large enough sections (ISUB=1, 2, 11-16, 18-20, 28-31, 53, 68) are generated together.

The background is investigated in the three intervals of the transverse energy of "photons":

$$E^{\gamma}_{Tmin} = 20,\ 40 \text{ and } 100\, GeV.$$

The simulation is carried out with PYTHIA parameter:

$$\texttt{CKIN(3)} \equiv \hat{p}^{min}_{\perp} = \frac{1}{2} E^{\gamma}_{Tmin}/c = 10,\ 20 \text{ and } 50\, GeV/c$$

accordingly for the each interval of the transverse energy of the "photon".

The reason of such a choice of `CKIN(3)` pursues 2 purposes:

a) to take into account "photons", generated at small P_T in hard process: $\hat{p}_{\perp} < P^{\gamma}_T$;

b) to have the correct spectrum of the imbalance $E^{\gamma}_T - E^{jet}_T$ which is essentially narrowed when generation goes under condition $\hat{p}_{\perp} \approx P^{\gamma}_T$.

For the preliminary selection of the events at the particle level the events satisfying the following conditions are selected:

- In η-ϕ-space (η is pseudo-rapidity, ϕ is polar angle) there exists the area with the size of 4×4 of crystals of the electromagnetic calorimeter in which there is only one electron, photon or K^0_S (last relied stable at the level generation and its decay is performed during propagation through detector) with transverse momentum more than $5\, GeV/c$;
- the sum of the transverse momenta of the stable particles (neutrino is excluded) in the specified area "4×4" ($P^{4\times4}_T$) reaches the value E^{γ}_{Tmin}/c:

  $$P^{4\times4}_T \ > \ 20,\ 40 \text{ or } 100\, GeV/c$$

  according to the considered intervals on E_T of "photon";
- there are no hadrons with the transverse momenta more than $10\, GeV/c$ in the area "4×4" crystalls;
- the sum of the transverse momenta of the stable particles (without neutrino) in the cone of the radius 0.7 described around the area of the "4×4" crystalls in the η-ϕ space does not exceed $25\%\ P^{4\times4}_T$;

- the same sum without taking into account the charged particles with transverse momenta $P_T < 2GeV/c$ does not exceed 20% $P_T^{4\times4}$.

Under the specified conditions 400 million events are generated and 50 000 events are selected in each interval on E_T of "photon" [7].

3 The effect of the electronics noise.

The study of the influence of the electronics noise on the possibility to suppress background to $\gamma + jet$ channel is carried out with the detailed simulation of detector [6]. The reconstructed energy of the noise generated in cells of calorimeters has the normal law of distribution with parameters:

$$\begin{aligned}
\mu &= 0;\\
\sigma &= 30\,MeV \quad \text{in a barrel of the electromagnetic calorimeter,}\\
\sigma &= 150\,MeV \quad \text{in a endcap of the electromagnetic calorimeter,}\\
\sigma &= 150\,MeV \quad \text{in hadron calorimeter.}
\end{aligned}$$

Only cells with the values of the reconstructed allocated energy exceeded with value $E^{cell}_{min} = 2\sigma$ are taken into account.

The noise of the electronics essentially worsen the possibility to separate the signal from ($\gamma + jet$) and background events using isolation of the "photon". Fig.1 illustrates this possibility at 4 levels of detalization of the simulation of the detector without pile up:

"$PARTICLE$" – CMSJET without simulation a magnetic field and energy and spatial smearing;

"$FIELD$" – CMSJET with magnetic field ($4T$) and without specified smearing;

"$SMEAR$" – CMSJET with magnetic field and with specified smearing;

"$NO\ PILEUP$" – CMSIM 121 + ORCA 4.5.4 without pileup.

As the isolation criteria we use $E^{isol}_{T\gamma}$ which is the scalar sum of E_T of calorimeter cells belonging to the cone of the radius $R = 0.7$ outlined around the "photon" except the 7×7 crystals of the electromagnetic calorimeter around the "photon" candidate.

The spectra of $E^{isol}_{T\gamma}$ for the signal and background events are shown on the Fig. 2. At the "$NO\ PILEUP$" level the signal and the background are separated much more worse than at "$PARTICLE$" level.

Apparently from Fig.2, it is possible to achieve the best separation of the signal and the background increasing the threshold E^{cell}_{min} from 2σ to 3σ.

The other possibility of background suppression is connected with the selection of the events imposing restrictions on the values $E^{isol}_{T\gamma}$ calculated for cones of various radii R. Fig.3 shows that the values of the allocated and reconstructed transverses energy in the vicinity of the direct photons and jets differ and also the difference is kept on the far periphery: $R \approx 1.5$. Therefore for the direct photons it is possible to use the values of $E^{isol}_{T\gamma}$ calculated for cones with $R \leq 1.5$.

Fig.4 shows that imposing the restrictions on the values of $E^{isol}_{T\gamma}$ change the parities of the signal (S) and the background (B) in the selected events depending on the efficiency of the signal suppression Eff_S. Results are presented for the cones $R = 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1$ and 1.5 and the thresholds $E^{cell}_{min} = 2\sigma,\ 2.2\sigma,\ 2.4\sigma,\ 2.7\sigma,\ 3\sigma$ and 3.5σ. The corresponding restrictions on $E^{isol}_{T\gamma}$ are shown on Fig.5. According to Fig.4 the best background suppression is observed at values $R = 0.7 \div 1.5$ and $E^{cell}_{min} \approx 3\sigma$.

4 The background suppression at low luminosity.

The pile up events affect on the possibility to separate signal and background events using isolation criteria so as the electronics noise. In Fig.6-7 the results of the possibility of the background suppression are shown imposing the restrictions on the isolation of the "photons" depending on the efficiency of the signal suppression and the cuts on calorimeter cells. The comparison of Fig.6 and Fig.4 shows, that pile up essentially spoils the situation with the background. The restriction on $E^{isol}_{T\gamma}$ works better at $R = 0.5 \div 0.7$. and $E^{cell}_{min} \approx 3\sigma$.

In addition to the isolation criteria we investigate the possibility of applying restrictions to the following quantities:

E^{isol}_{Tjet} the isolation of the jet - the scalar sum of transverse energy (E_T) in the cells of the calorimeters belonging to a ring of $0.7 < R < 1$ in the vicinity of the jet;

E^{miss}_{T} is the loss of the transverse energy in the setup - the vector sum of E_T in the all cells of calorimeters;

$\Delta\phi$ is interval on the polar angle ϕ between vectors: E_T jet and the "photon" (thus the jet gathered in calorimeters in cone R=0.7, and a "photon" - in 3×3 crystals of an electromagnetic calorimeter);

E^{jet2}_{T} is the largest transverse energy of additional jet;

E^{out1}_{T} is the vector sum of E_T of the calorimeter cells except the area of the 7×7 crystals of the electromagnetic calorimeter in the vicinity of a "photon" and the area of radius R=0.8 in the vicinity of the jet;

E^{out1}_{Ts} is the scalar sum of E_T in the same cells;

E^{out2}_{T} is the vector sum of E_T in the calorimeter cells except cells in the cone of radius R = 0.8 in the vicinity of the "photon" and the cone of the same size in the vicinity of the jet;

E^{out2}_{Ts} is the scalar sum of E_T in the same cells.

We investigate both the particles level("$PARTICLE$") and reconstruction level without pile up ("$NO\ PILEUP$" level) and with the pile up corresponded to low luminosity pile up ("$LOW\ LUMI$" level).

In Fig.8-9 the parities of the signal (S) and the background (B) in the selected events are shown depending on the efficiency of the signal suppression Eff_S at imposing restrictions on the various parameters of the event. Values of these restrictions are presented in Fig.10-11. One can see that as well as in the case with selection of events on isolability of "photons" and with selections on other variables the effect of imposing of events essentially worsens the possibility of the background suppression.

The result of simultaneous imposing of the various restrictions is shown in Fig.12. The values of the restrictions correspond to $Eff_S = 90\%,\ 50\%$ and 10% are given in Tabl.1. The selections on E^{jet2}_{T}, $\Delta\phi$, E^{out1}_{T}, E^{out1}_{Ts} and on 4 quantities $E^{isol}_{T\gamma}$ which are calculated at $R = 0.5,\ 0.7,\ 1$ and 1.5 and the cut on the cell energy $E^{cell}_{min} \approx 3\sigma$ is also applied.

The cuts on the other parameters mentioned above do not improve suppression essentially.

Apparently seen from Fig.12 that the effects of detector essentially worsen the situation with the background in comparison with the particle level.

In the same figure one can see that the significant part of the background comes from the photons from mesons decay. Therefore the background can be partially suppressed under condition of the better recognition of background from π^0 and other mesons.

The tracker can provide the additional possibility of the background suppression. Let us consider the ideal tracker where all tracks belonging to the hard events and to pile up ones are separated. Let us demand that in the some cone around the "photon" there are no tracks of the charged particles with $P_T > 1\,GeV/c$. The efficiency of the signal suppression and the ratio S/B are given on Fig.13 depending on the radius of the cone R. Even in such an ideal case no essential suppression can be expected. Let's note, that the ratio S/B has the largest values at the largest possible $R \approx 1.5$ and with cut on $P_T \approx 1$ GeV/c.

5 Influence of a background on calibration at low luminosity pile-up.

Let's determine the calibration coefficient for jet k_{jet} as the position of maximum of distribution $\frac{E^{jet}_{Treco}}{E^{\gamma}_{Treco}}$, where E^{jet}_{Treco} is the transverse energy of the leading jet. And the position of the maximum is found by the gaussian fit.

The distribution of the $\frac{E^{jet}_{Treco}}{E^{\gamma}_{Treco}}$ with and without background obtained with the restriction according to the 50% of the signal suppression is presented on the Fig. 14(a,b) correspondingly. One can see that already at soft selections with $Eff_S = 50\%$, when the background still prevails over the signal, the distributions with and without background differ only by values of dispersions. The positions of peaks μ_S and μ_{S+B} practically coincide.

The dependance of the position of the maximum of the $\frac{E^{jet}_{Treco}}{E^{\gamma}_{Treco}}$ distribution with background on the efficiency of signal is shown on the Fig. 14c. The dependance of the relative shift of the maximum because of background on the efficiency of signal is shown on the Fig. 14d. Since rather soft selections ($Eff_S > 70\%$) the shift of the maximum becomes insignificant. It means, that background events after the appropriate selections quite can be suitable for setting of a jet energy scale.

6 Conclusion.

Essential prevalence of the signal over the background at low luminosity in the investigated area of Eff_S values is observed only at $E^{\gamma}_T > 100\,GeV$ and $Eff_S < 10\%$ (Fig.12). Let's note, that thus we shall have sufficient for calibration number of events: $\approx 5 \cdot 10^5$ for 3 months of work of setup.

The high level of the background at $E^{\gamma}_T \approx 20$ and 40 GeV does not exclude the possibility of $\gamma + jet$ calibration at the given E_T. The predicted numbers of $\gamma + jet$ events collected for the 3 months of the run at low luminosity are $\approx 5 \cdot 10^8$ and $\approx 7 \cdot 10^7$ for $E^{\gamma}_T > 20$ and $40\,GeV$ correspondingly. Therefore we have enough statistics to increase the ratio S/B using the more hard selection of events off-line.

The study of the errors introduced by the background to the calibration shows, that even the significant amount of the background events after the certain selections might be acceptable of the calibration purposes. However this point requires the additional investigation with higher statistics.

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References

[1] D.V. Bandourin, V.F. Konoplyanikov, N.B. Skachkov. JINR Preprint E2-2000-255, JINR, Dubna.

[2] V.Konoplianikov, V.Palichik, E.Tikhonenko, O.Kodolova. CMS IN 2002/014.

[3] T.Sjostrand. Comp.Phys.Com. 82 (1994) 74.

[4] S.Abdullin, A.Khanov, N.Stepanov, CMS Note CMS TN/94-180.

[5] CMSIM user's Guide at http://cmsdoc.cern.ch/swsi.html

[6] ORCA user's Guide at http://cmsdoc.cern.ch/orca

[7] CERN Spring production at http://computing.fnal.gov/cms/jpg/Default.html

Tabl.1. The cuts applying to the indicated parameters for the efficiency of the signal suppression $Eff_S = 90,\ 50$ and 10%. Different levels of the detalization of the simulation are considered: $"PARTICLE"$, $"NO\ PILEUP"$ and $"LOW\ LUMI"$.

a) Case $20 < E_T^{\gamma} < 30\,GeV$

Levels	$"PARTICLE"$			$"NO\ PILEUP"$			$"LOW\ LUMI"$		
Eff_S	90%	50%	10%	90%	50%	10%	90%	50%	10%
$E_T^{jet2}\ (GeV)$	23	14	10	19	13	10	21	16	12
$180^\circ - \Delta\phi^\circ$	81	35	16	175	54	19	150	74	20
$E_T^{out1}\ (GeV)$	27	14	8	25	16	10	42	29	18
$E_{Ts}^{out1}\ (GeV)$	140	108	86	178	156	139	-	-	-
$E_{T\gamma,\ R=0.5}^{isol}\ (GeV)$	-	-	-	-	-	-	4.7	2.7	0.9
$E_{T\gamma,\ R=0.7}^{isol}\ (GeV)$	5.8	3.0	0.9	4.5	1.8	0.7	-	-	-
$E_{T\gamma,\ R=1.0}^{isol}\ (GeV)$	10.5	5.9	2.1	6.2	3.1	1.0	-	-	-
$E_{T\gamma,\ R=1.5}^{isol}\ (GeV)$	21.1	13.0	5.9	13.3	7.9	3.8	-	-	-

b) Case $40 < E_T^{\gamma} < 55\,GeV$

Levels	$"PARTICLE"$			$"NO\ PILEUP"$			$"LOW\ LUMI"$		
Eff_S	90%	50%	10%	90%	50%	10%	90%	50%	10%
$E_T^{jet2}\ (GeV)$	32	20	12	27	17	11	31	22	17
$180^\circ - \Delta\phi^\circ$	43	24	12	46	25	14	47	24	13
$E_T^{out1}\ (GeV)$	34	20	9	29	17	10	49	32	24
$E_{Ts}^{out1}\ (GeV)$	152	120	91	190	163	143	-	-	-
$E_{T\gamma,\ R=0.5}^{isol}\ (GeV)$	-	-	-	-	-	-	8.2	3.9	1.4
$E_{T\gamma,\ R=0.7}^{isol}\ (GeV)$	6.2	3.0	0.9	6.0	2.2	0.7	-	-	-
$E_{T\gamma,\ R=1.0}^{isol}\ (GeV)$	12.3	6.0	2.2	10.0	4.6	1.4	-	-	-
$E_{T\gamma,\ R=1.5}^{isol}\ (GeV)$	33.2	19.7	8.0	18.8	12.0	4.9	-	-	-

c) Case $100 < E_T^{\gamma} < 130\,GeV$

Levels	$"PARTICLE"$			$"NO\ PILEUP"$			$"LOW\ LUMI"$		
Eff_S	90%	50%	10%	90%	50%	10%	90%	50%	10%
$E_T^{jet2}\ (GeV)$	69	45	24	62	35	17	57	33	20
$180^\circ - \Delta\phi^\circ$	42	21	10	44	23	13	43	22	14
$E_T^{out1}\ (GeV)$	72	42	18	59	33	15	64	35	21
$E_{Ts}^{out1}\ (GeV)$	219	160	124	234	190	159	-	-	-
$E_{T\gamma,\ R=0.5}^{isol}\ (GeV)$	-	-	-	-	-	-	9.5	3.9	1.4
$E_{T\gamma,\ R=0.7}^{isol}\ (GeV)$	8.2	2.9	0.4	10.4	3.4	0.8	-	-	-
$E_{T\gamma,\ R=1.0}^{isol}\ (GeV)$	17.5	7.6	3.2	14.2	5.4	1.8	-	-	-
$E_{T\gamma,\ R=1.5}^{isol}\ (GeV)$	42.3	23.1	14.0	36.1	16.2	9.6	-	-	-

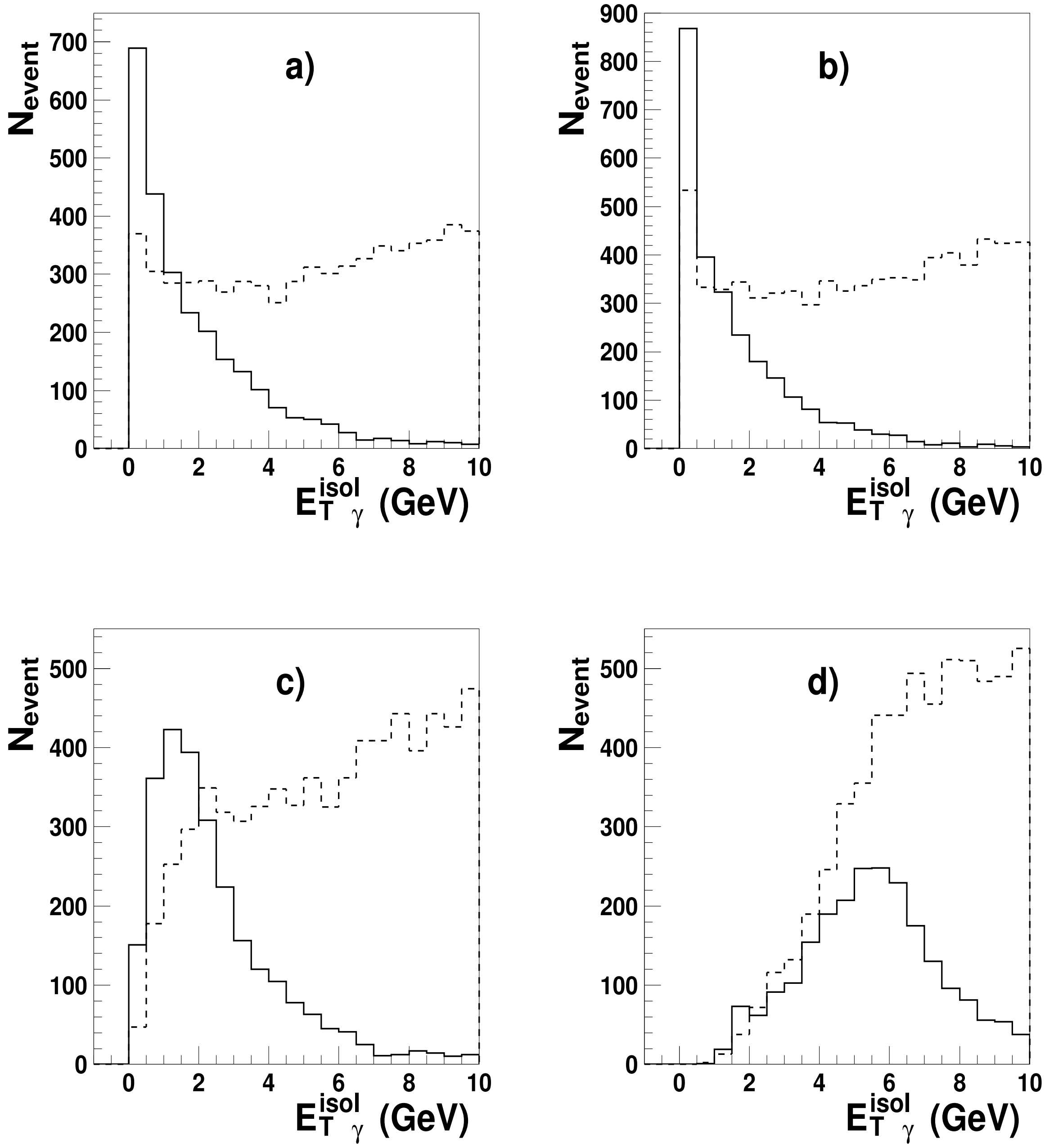

Figure 1: $E_{T\gamma}^{isol}$ spectra in events with direct photons (continuous line) and background events (dashed line) for different levels of simulation $"PARTICLE"$ (a), $"FIELD"$ (b), $"SMEAR"$ (c) $"NO\ PILEUP"$ (d). Cone raduis $R = 0.7$, $E_{min}^{cell} = 2\sigma$, $40 < E_T^{\gamma} < 100 GeV$.

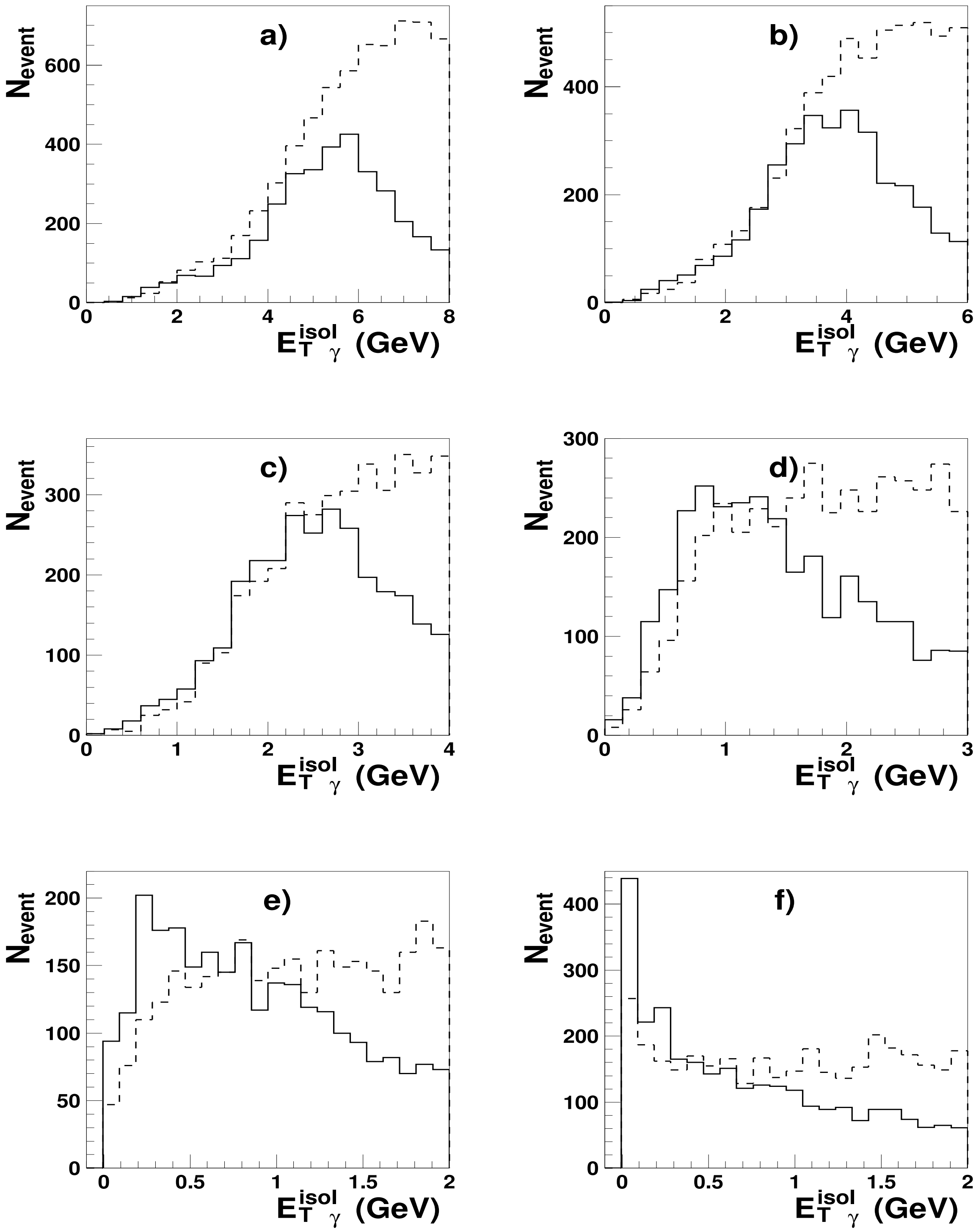

Figure 2: $E_{T\gamma}^{isol}$ spectra in events with direct photons (continuous line) and background events (dashed line) at the level "$NO\ PILEUP$" with the various values of the threshold on calorimeter cell $E_{min}^{cell} = 2\sigma$ (a), 2.2σ (b), 2.4σ (c), 2.7σ (d), 3σ (e) and 3.5σ (f). Cone radius $R = 0.7$, $40 < E_T^{\gamma} < 100\, GeV$.

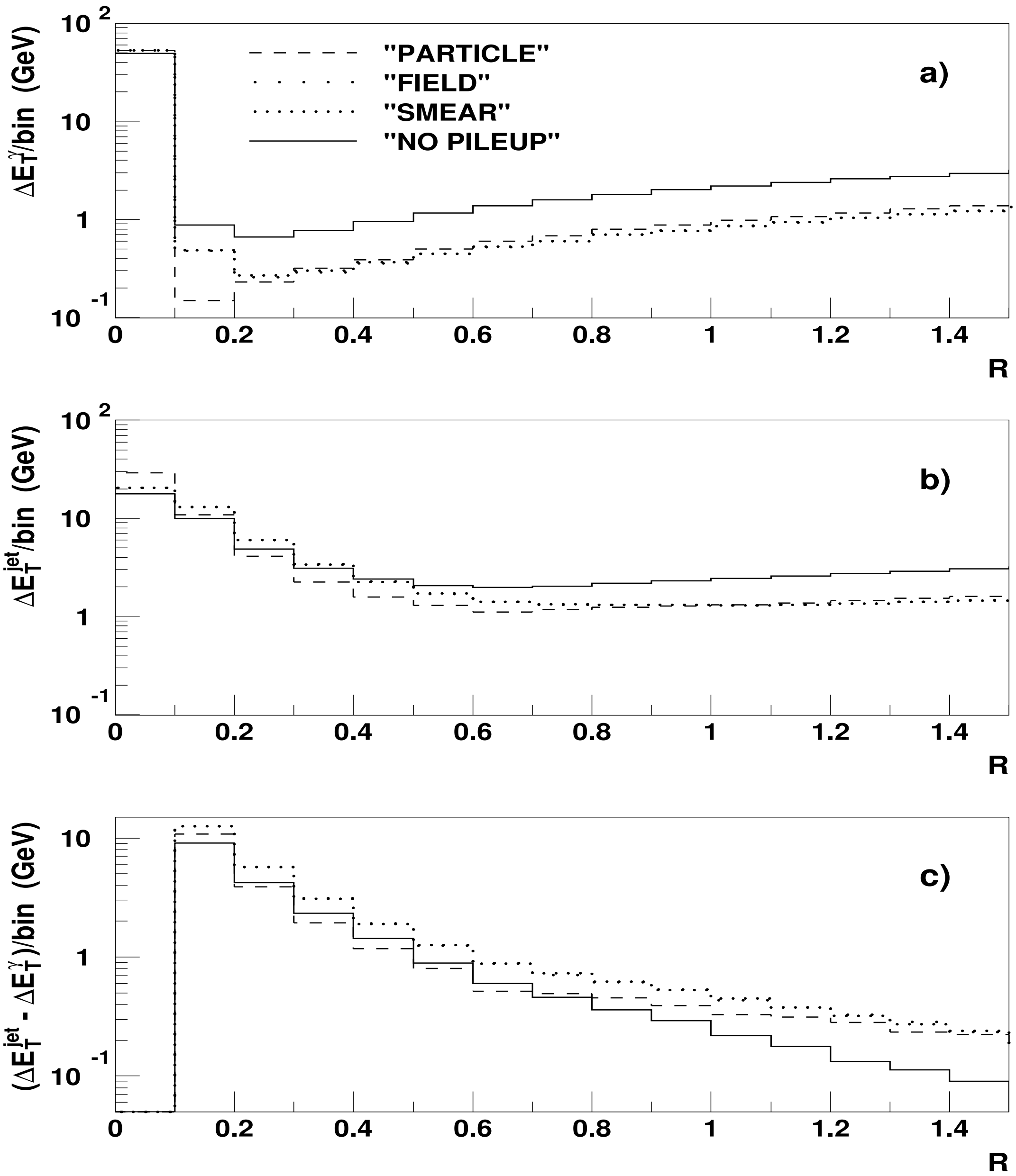

Figure 3: The average E_T in the rings in around the direct photon (a), around the jet (b) and differences of these values (c). The direct photons from the interval $40 < P_T^{\gamma} < 100\,GeV$ are used for the "$PARTICLE$", "$FIELD$", "$SMEAR$" and "$ORCA$" levels.

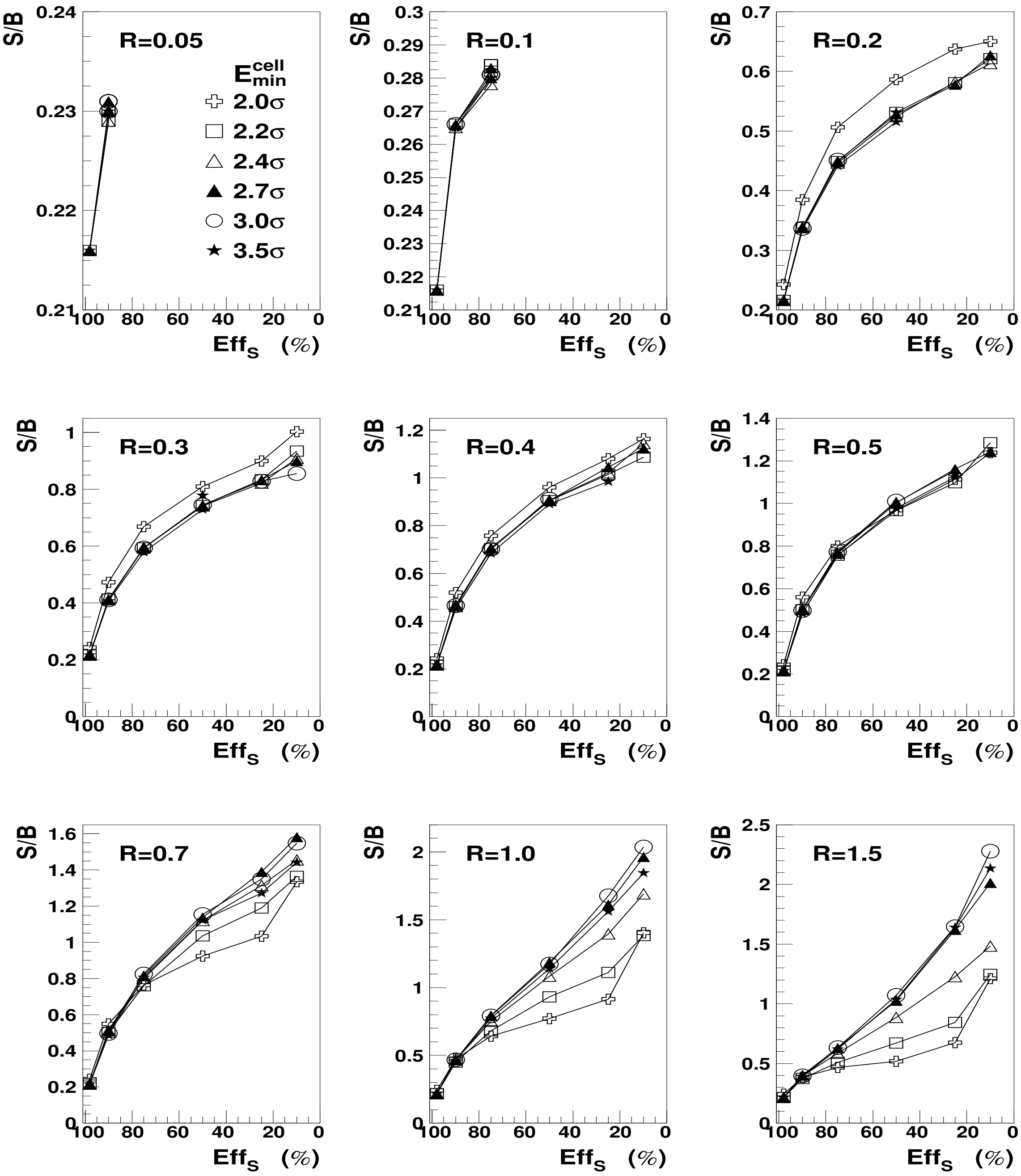

Figure 4: Ratio of numbers of events with direct photons (S) to numbers of background events (B) depending on efficiency of signal suppression Eff_S imposing restrictions on $E_{T\gamma}^{isol}$ for the cones R =0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1 and 1.5 and the thresholds $E_{min}^{cell} = 2\sigma,\ 2.2\sigma,\ 2.4\sigma,\ 2.7\sigma,\ 3\sigma$ and 3.5σ ($40 < E_T^{\gamma} < 100 GeV$. The sample without pile-up is used.)

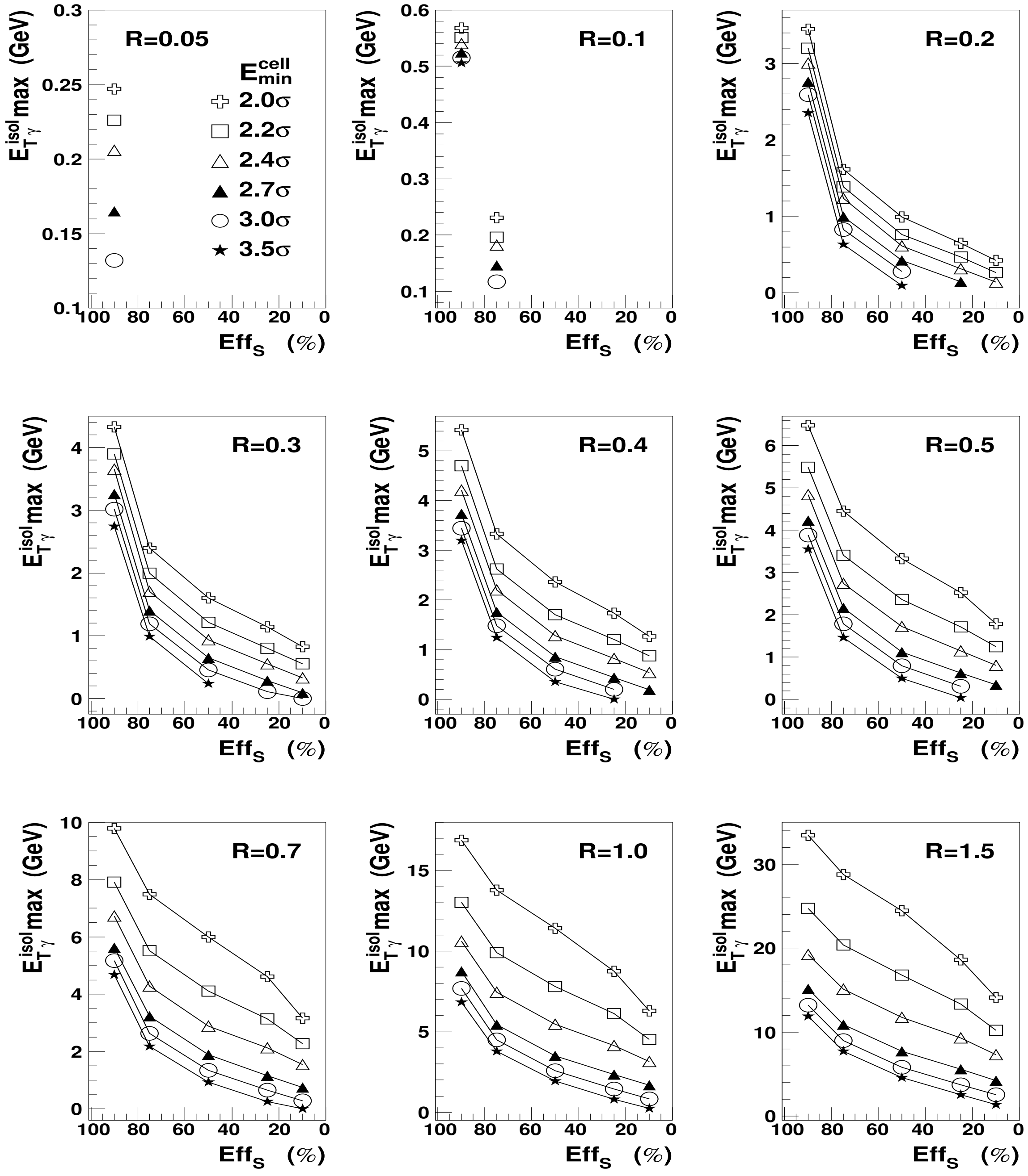

Figure 5: The dependance of the cuts on $E_{T\gamma}^{isol}$ on the efficiency of the signal suppression Eff_S for the cones R =0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1 and 1.5 and the thresholds $E_{min}^{cell} = 2\sigma,\ 2.2\sigma,\ 2.4\sigma,\ 2.7\sigma,\ 3\sigma$ and 3.5σ ($40 < E_T^{\gamma} < 100 GeV$. The sample without pile-up is used.

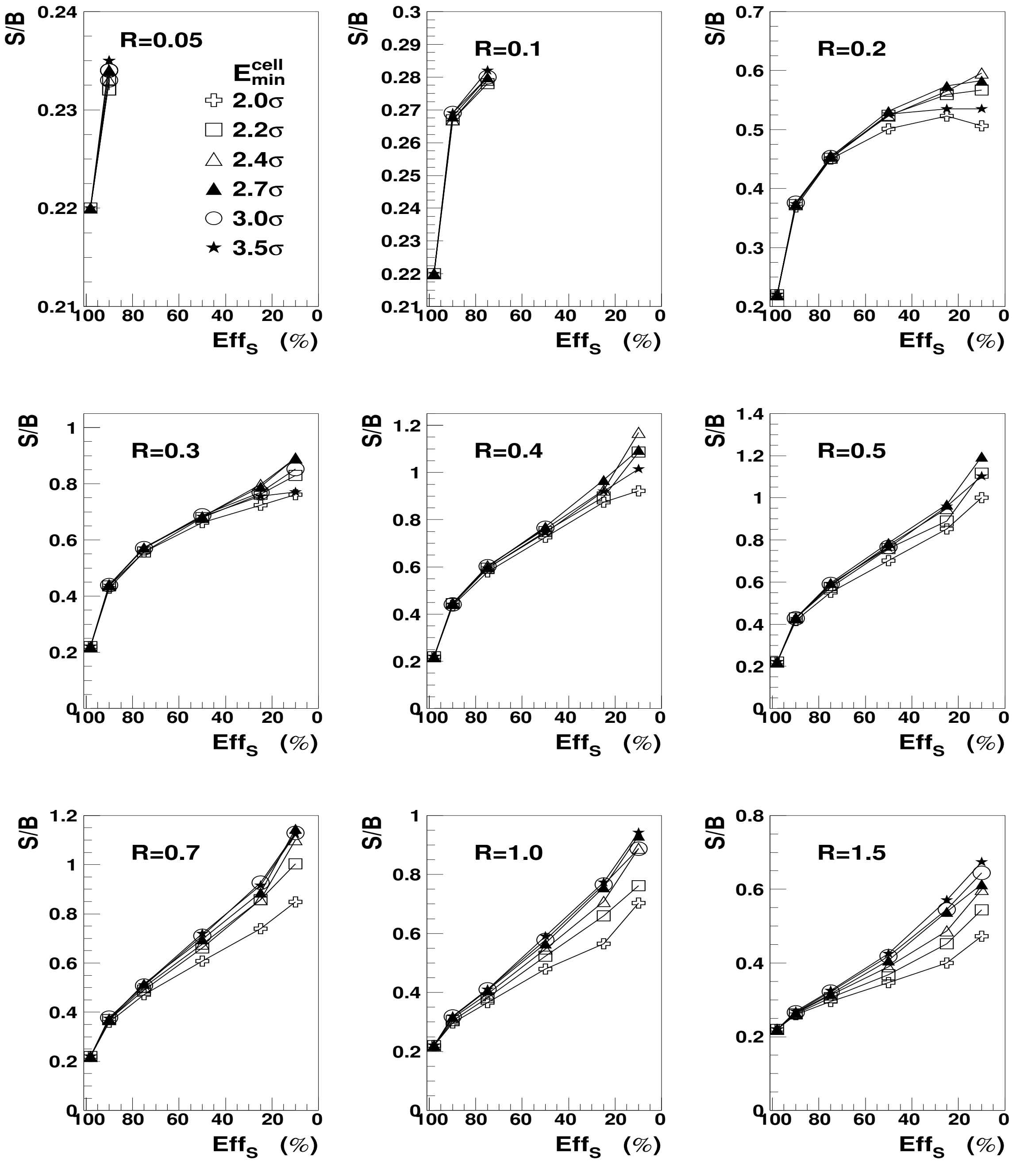

Figure 6: Ratio of numbers of events with direct photons (S) to numbers of background events (B) depending on efficiency of signal suppression Eff_S imposing restrictions on $E^{isol}_{T\gamma}$ for the cones $R =$0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1 and 1.5 and the thresholds $E^{cell}_{min} = 2\sigma,\ 2.2\sigma,\ 2.4\sigma,\ 2.7\sigma,\ 3\sigma$ and 3.5σ ($40 < E^{\gamma}_{T} < 100 GeV$. The sample with low luminosity pile-up is used.)

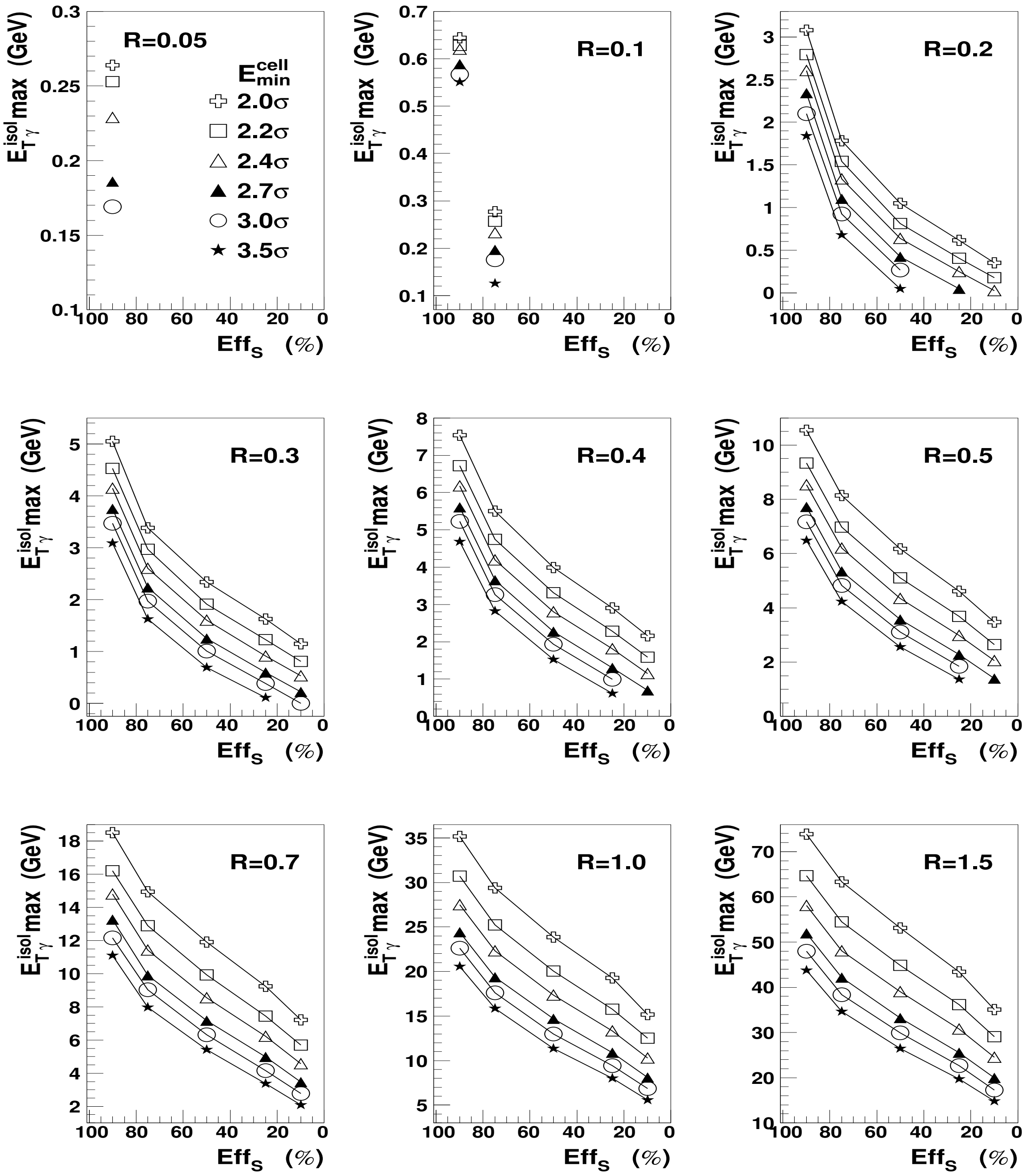

Figure 7: The dependance of the cuts on $E^{isol}_{T\gamma}$ on the efficiency of the signal suppression Eff_S for the cones R =0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1 and 1.5 and the thresholds $E^{cell}_{min} = 2\sigma,\ 2.2\sigma,\ 2.4\sigma,\ 2.7\sigma,\ 3\sigma$ and 3.5σ ($40 < E^{\gamma}_{T} < 100 GeV$. The sample without pile-up is used.)

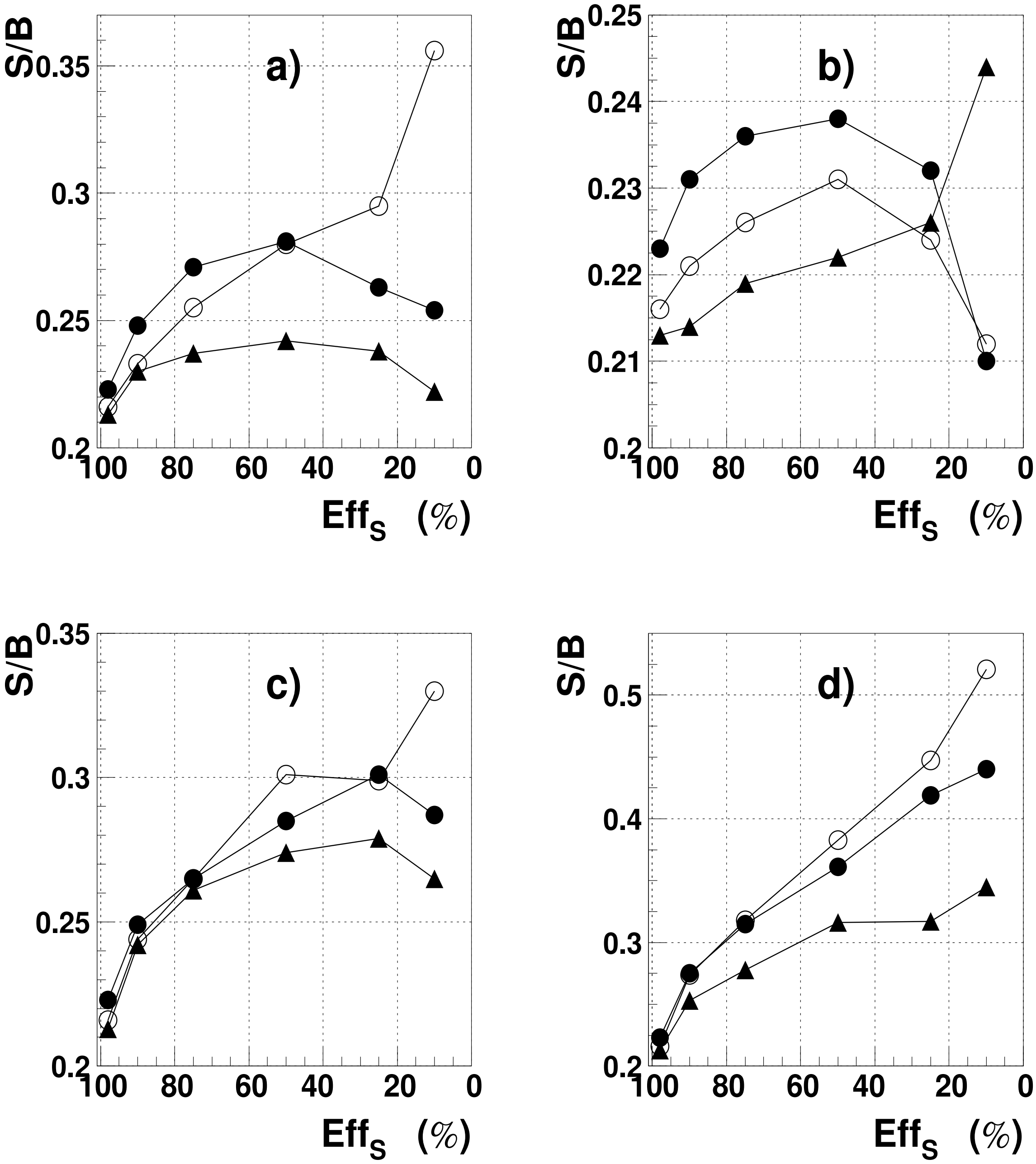

Figure 8: Ratio of numbers of events with direct photons (S) to the numbers of background events (B) depending on efficiency of signal suppression Eff_S with cuts on E^{isol}_{Tjet} (a), E^{miss}_T (b), $\Delta\phi$ (c) and E^{jet2}_T (d) for the levels of "$PARTICLE$" (white circles), "$NO\ PILEUP$" (black circles) and "$LOW\ LUMI$" (triangles).

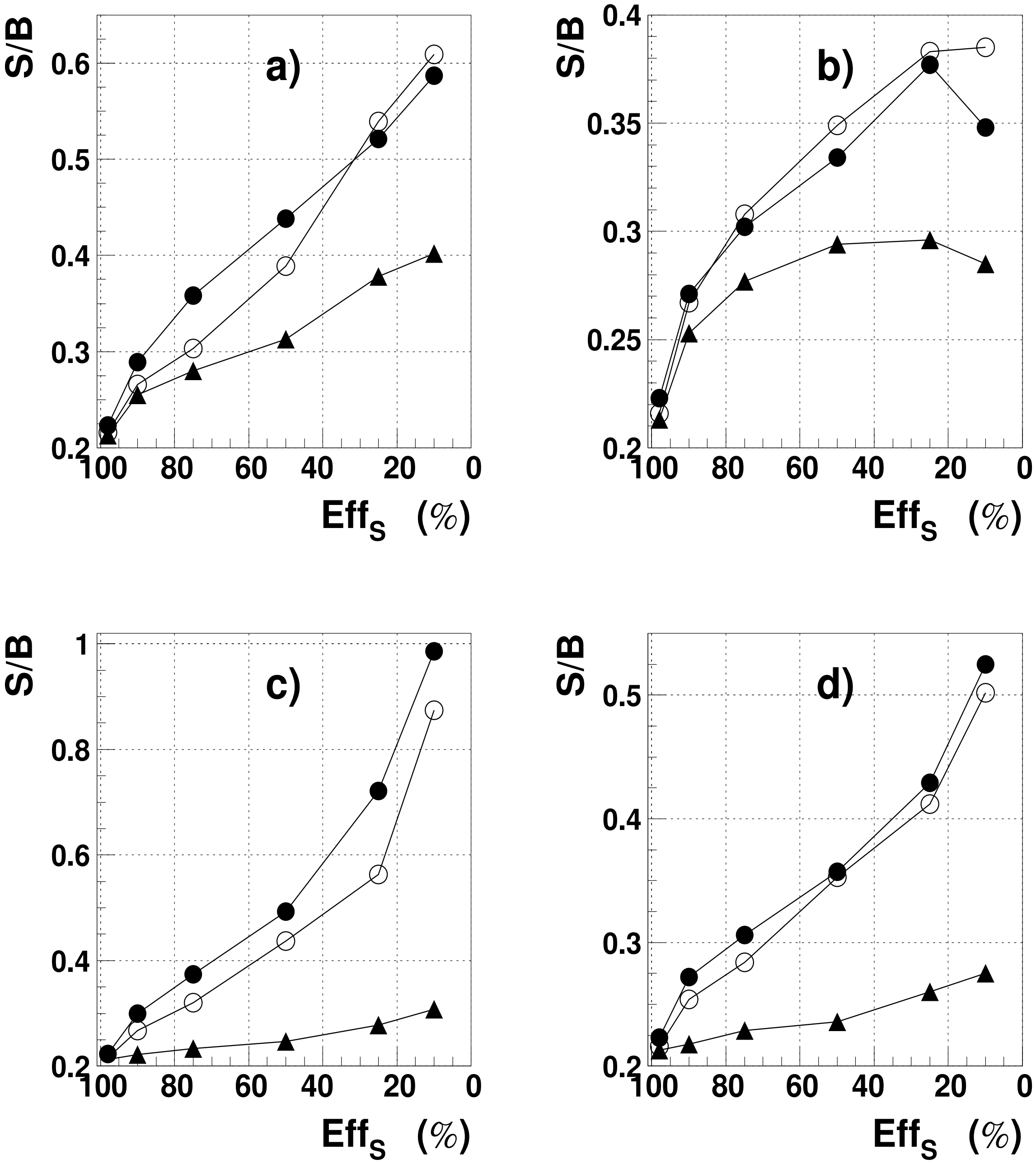

Figure 9: The ratio of the numbers of events with direct photons (S) to the numbers of background events (B) depending on the efficiency of signal suppression Eff_S with cuts on E_T^{out1} (a), E_T^{out2} (b), E_{Ts}^{out1} (c) and E_{Ts}^{out2} (d) for the levels of "$PARTICLE$" (white circles), "$NO\ PILEUP$" (black circles) and "$LOW\ LUMI$" (triangles).

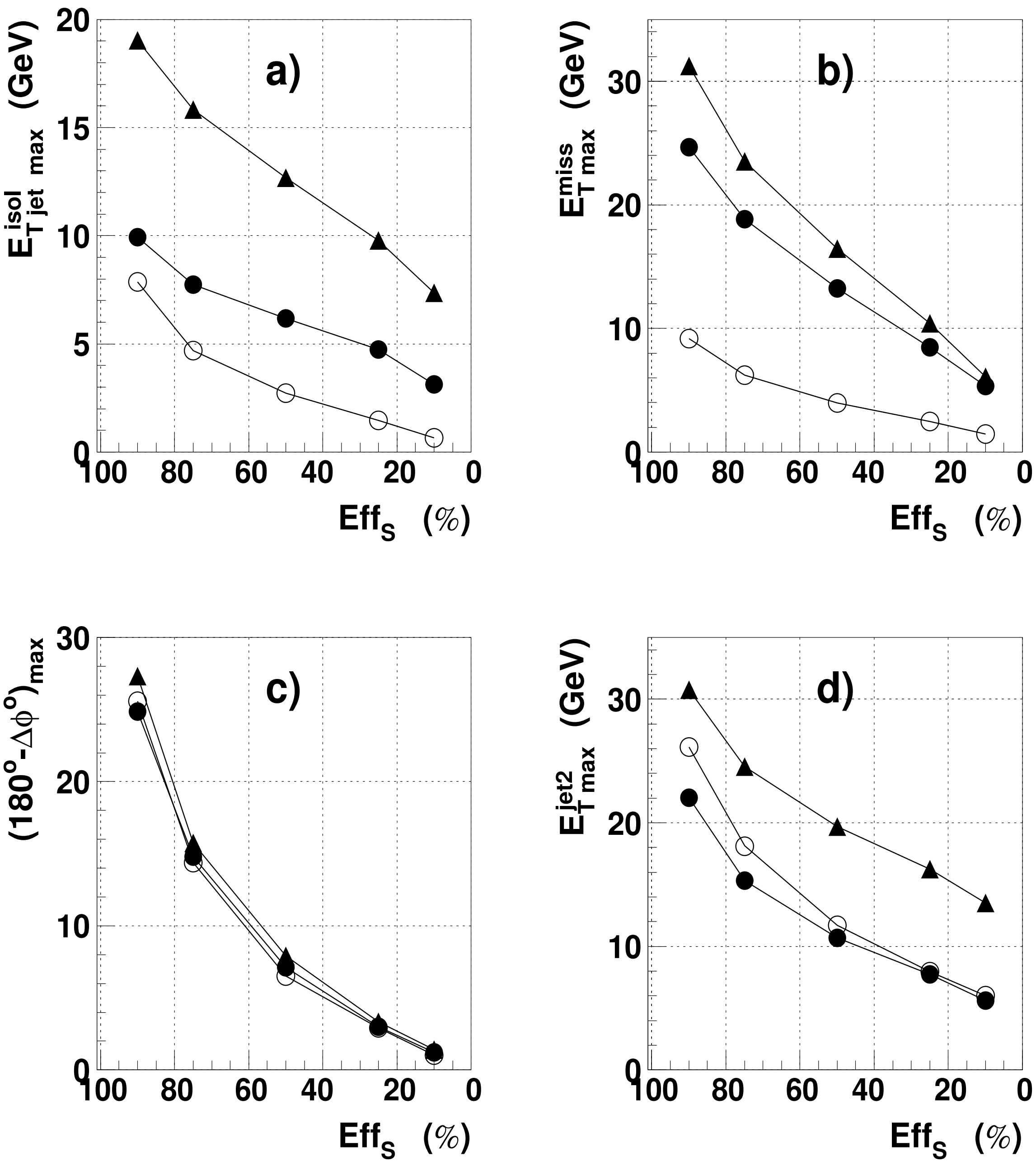

Figure 10: The dependance of the cuts E_{Tjet}^{isol} (a), E_T^{miss} (b), $\Delta\phi$ (c) and E_T^{jet2} (d) on the efficiency of signal suppression Eff_S for the levels of "$PARTICLE$" (white circles), "$NO\ PILEUP$" (black circles) and "$LOW\ LUMI$" (triangles).

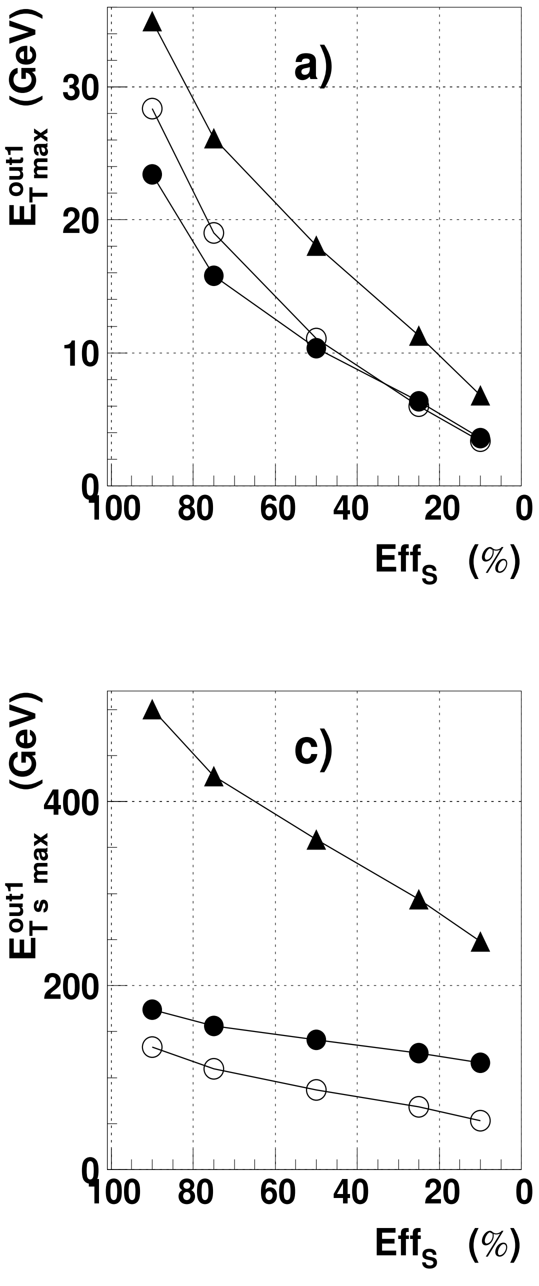

Figure 11: The dependance of the cuts E_T^{out1} (), E_T^{out2} (b), E_{Ts}^{out1} (c) and E_{Ts}^{out2} (d) on the efficiency of the signal suppression Eff_S for the levels of "$PARTICLE$" (white circles), "$NO\ PILEUP$" (black circles) and "$LOW\ LUMI$" (triangles).

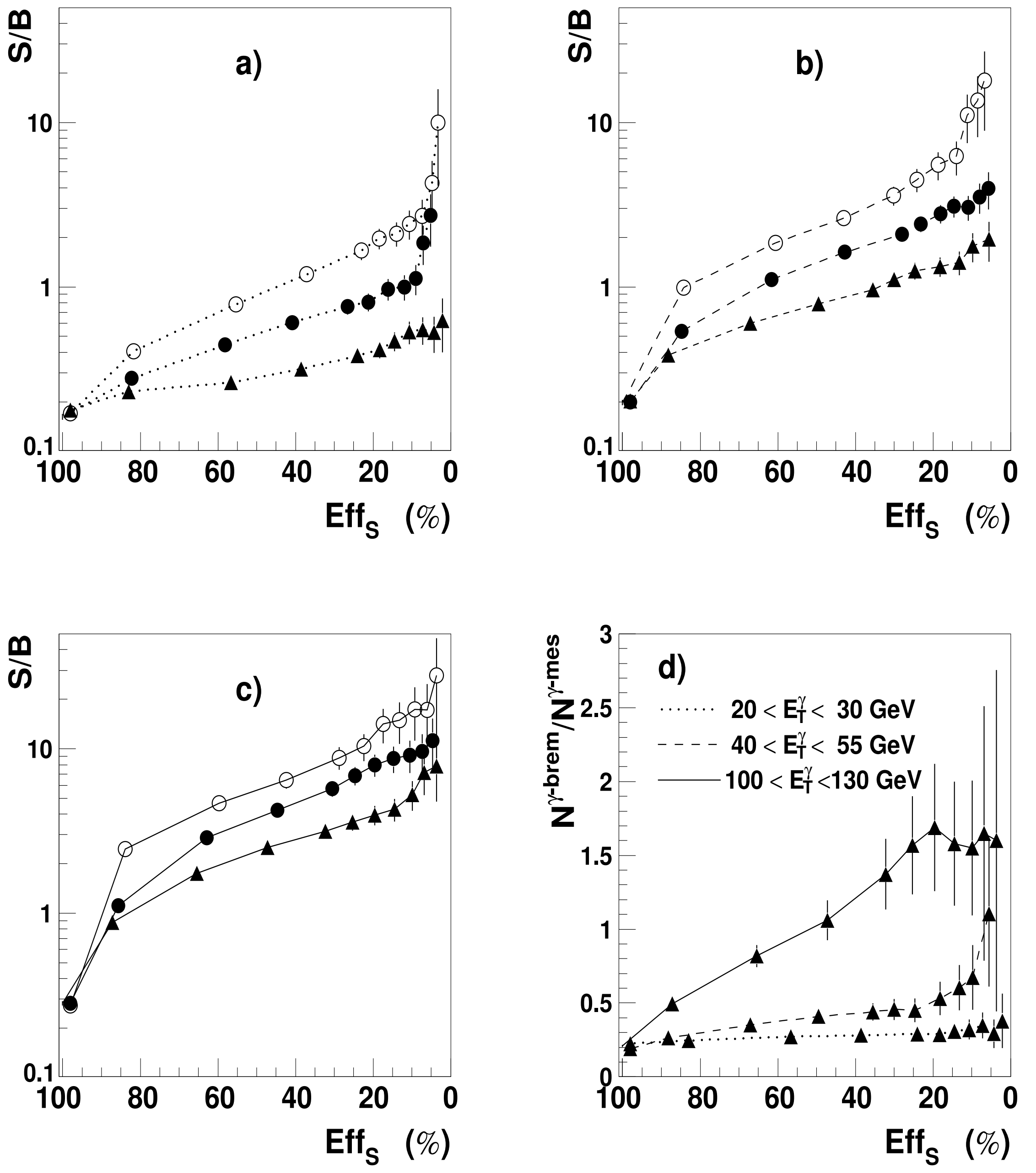

Figure 12: The dependance of the ratio of the numbers of the events with direct photons to the numbers of background events (S/B) for the levels "$PARTICLE$" (white circles), "$NO\ PILEUP$" (black circles) and "$LOW\ LUMI$" (triangles) in different intervals of E_T^γ: $20 \div 30$ (a), $40 \div 55$ (b) and $100 \div 130\, GeV$ (c) and the ratio of numbers of background events with bremsstrahlung photons ("$\gamma - brem$") to the number of background events with photons from mesons decays ("$\gamma - mes$") in the same intervals on E_T^γ for "$LOW\ LUMI$" (d) on the efficiency of the signal suppression Eff_S applying the different cuts on the various parameters of the event.

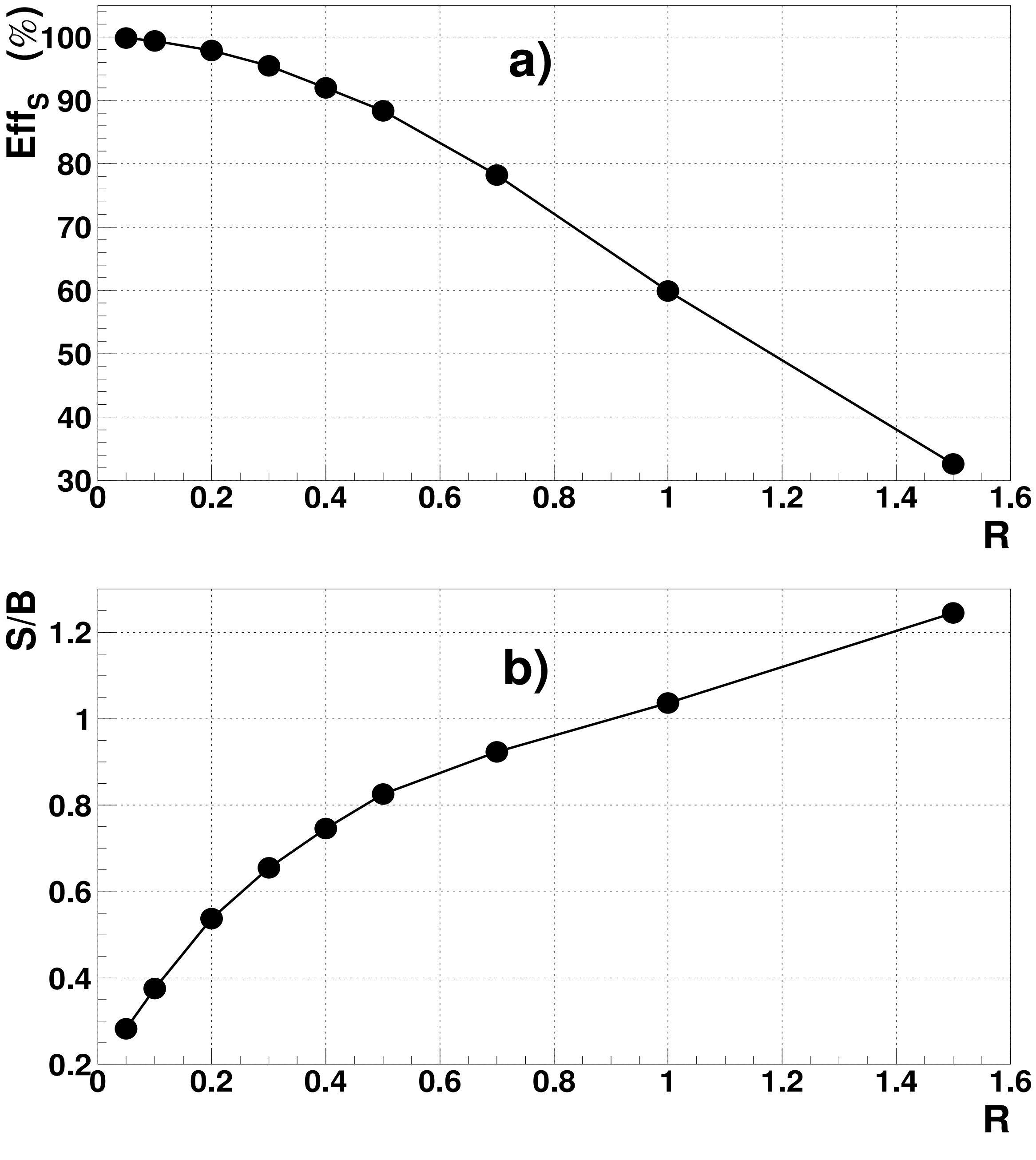

Figure 13: The dependance of the efficiency of signal suppression (a) and S/B on the radius of the cone R around "photon" assuming that no charged tracks with $P_T > 1\,GeV/c$ is in the cone. Ideal tracker is supposed. $40 < E_T^{\gamma} < 100 GeV$.

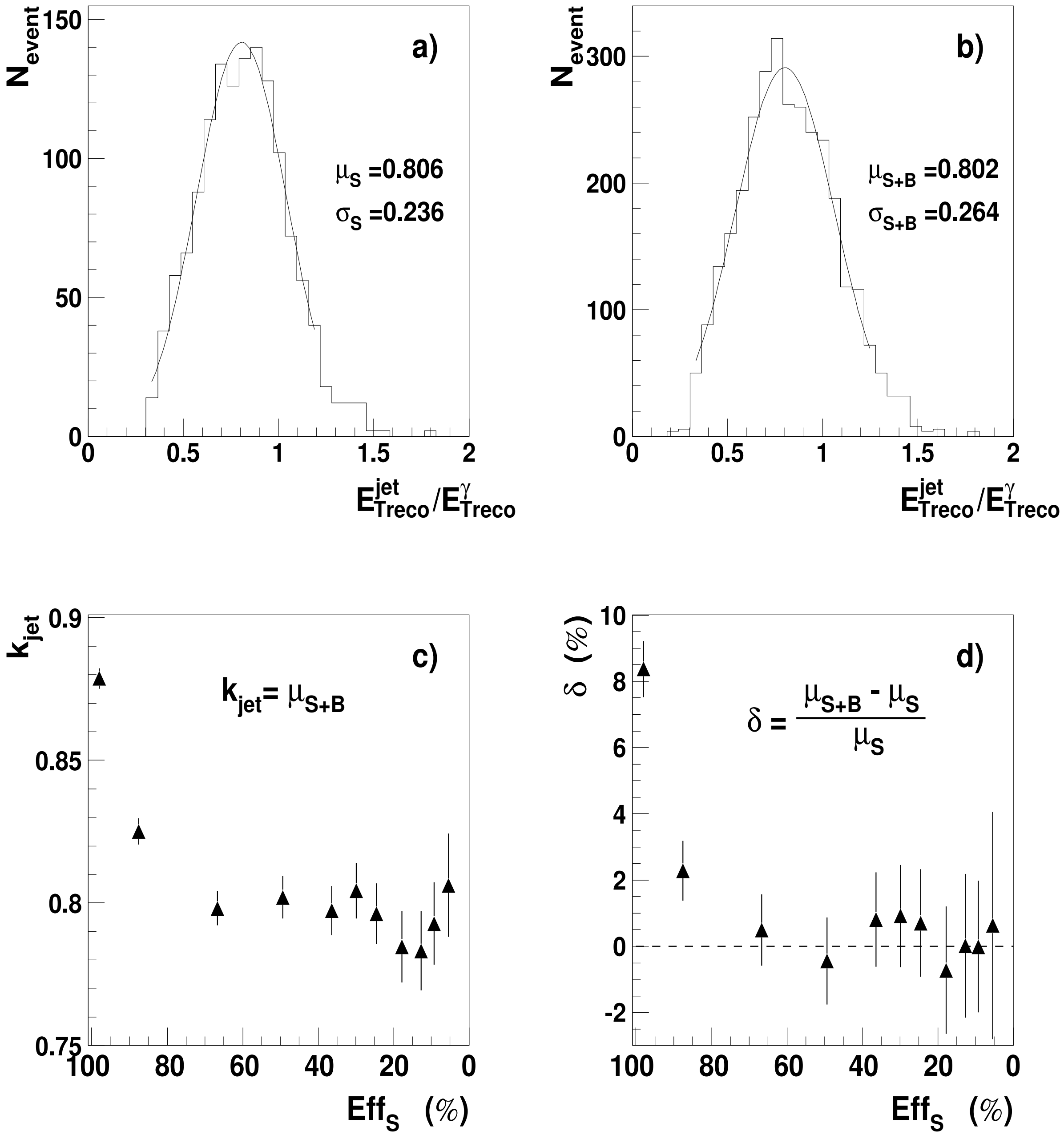

Figure 14: The distribution of the ratio of the reconstructed values of E_T^{jet} and E_T^{γ} assuming the signal us suppressed to the $Eff_S = 50\%$ in the events without background (a) and with background (b); The dependance of the calibration coefficient k_{jet} (c) and the systematic errors introduced by the background (d) on the efficiency of the signal suppression. "$LOW\ LUMI$" sample with $40 < E_T^{\gamma} < 55GeV$.