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γ + jet calibration. Background and errors.

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Study of a possibility of suppression of the background by the way of the event selection and an influence of the background on the calibration.

Used events with direct photons ($\gamma + jet$) and background ($jet + jet$) from Spring01 production

Parameters of the samples ”1” – ”3”.

Parameter	”1”	”2”	”3”
Pt^{γ}_{min} (GeV/c)	20	40	100
Pt^{γ}_{max} (GeV/c)	40	100	200
$\hat{p}_{\perp}$ min	10	20	50
$\hat{p}_{\perp}$ max	80	200	400
No of events	50000	50000	50000

Current production has been carried out with preliminary selection at the PYTHIA level:

Inside 4x4-region (4x4 crystals)

– should be e/γ with Pt $>$ 5 GeV/c;

– a sum of Pt of particles: Pt4x4 $> Pt^{\gamma}_{min}$;

– no hadrons with Pt $>$ 10 GeV/c.

Inside R = 0.7 and outside 4x4-region

– any number of charged particles with Pt $< 2GeV/c$;

– a sum of Pt for neutral + charged particles with

Pt $> 2GeV/c$ is $<$ 20$\%$ Pt4x4;

– a sum of Pt for all particles is $<$ 25$\%$ Pt4x4.

Backgrounds contents.

"$\gamma - mesons$" – **the photons from π^0, η, ω and K_S^0;**

"$\gamma - brem$" – **the photons were emmited from quarks.**

Background study levels:

"**PYTHIA**" – CMSJET v.4.703 without field and energy and spatial smearing;

"**FIELD**" – CMSJET with field and without energy and spatial smearing;

"**SMEAR**" – CMSJET with field and energy and spatial smearing;

"**ORCA**" – CMS121 + ORCA454

Influence of the background on the calibration

The task of calibration is to reconstruct Et^{jet} using Et^{γ}:

$$Et^{jet} = Et^{\gamma}$$

We have different values of disbalances:

$\Delta_S = \langle Et^{\gamma} - Et^{jet} \rangle_S$ – a case of signal events;

$\Delta_{S+B} = \langle Et^{\gamma} - Et^{jet} \rangle_{S+B}$ – a case of signal + background.

Thus background causes an error into the calibration:

$$\Delta_{S+B} - \Delta_S$$

Futher we shall characterize backgrounds by:

- **a part of background events B/(B+S);**
- **an errors** $\delta_{S+B} - \delta_S = (\Delta_{S+B} - \Delta_S)/Et^{\gamma}$**;**
- **an difference** $\sigma_{S+B} - \sigma_S$ **(**σ **= RMS of** Et^{γ}**-**Et^{jet}**).**

For background suppression we put constraints (selection cuts) on the values:

$\mathbf{Et}_{\gamma}^{isol}$ – summarized Et in the R=0.7 outside 3x3 crystals,

$\Delta\phi$ – angle between "γ" and jet

$\mathbf{Et}^{jet2}$ – Et of the second jet

$\mathbf{Et}^{out}$ – vector sum of Et outside 3x3 crystals and outside jet

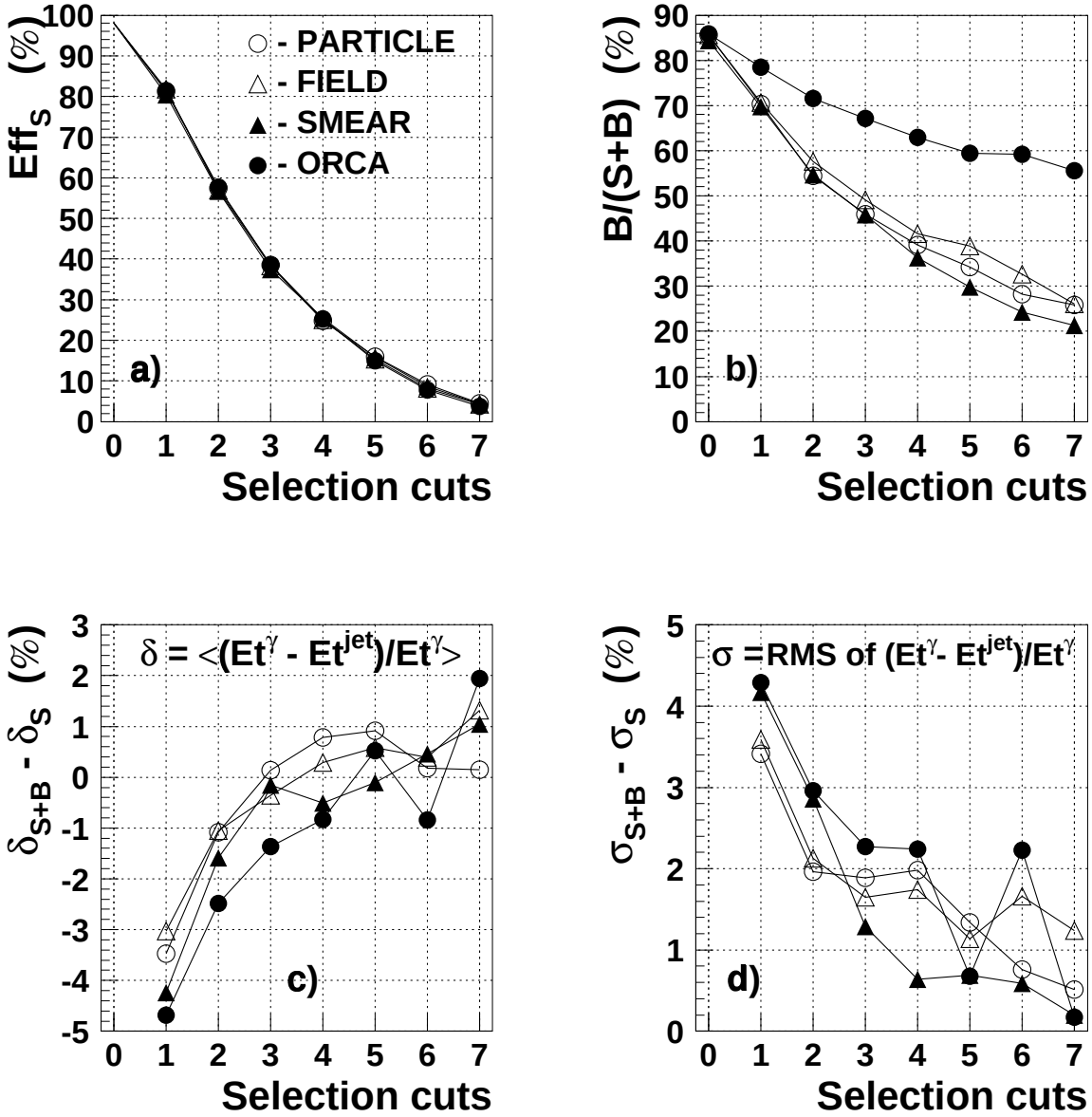
We study background with soft and hard cuts (1-7), with the simultaneous limitation on the $\mathbf{Et}_{\gamma}^{isol}$, $\Delta\phi$... The each of the selection cuts 1 – 7 is connected with the efficiency of signal suppresion (Eff$_S$):

Selection cuts	1	2	3	4	5	6	7
Eff$_S$ (%)	83	60	40	27	17	10	5

We have at ORCA-level for $Et^{\gamma} = 100\ GeV$:

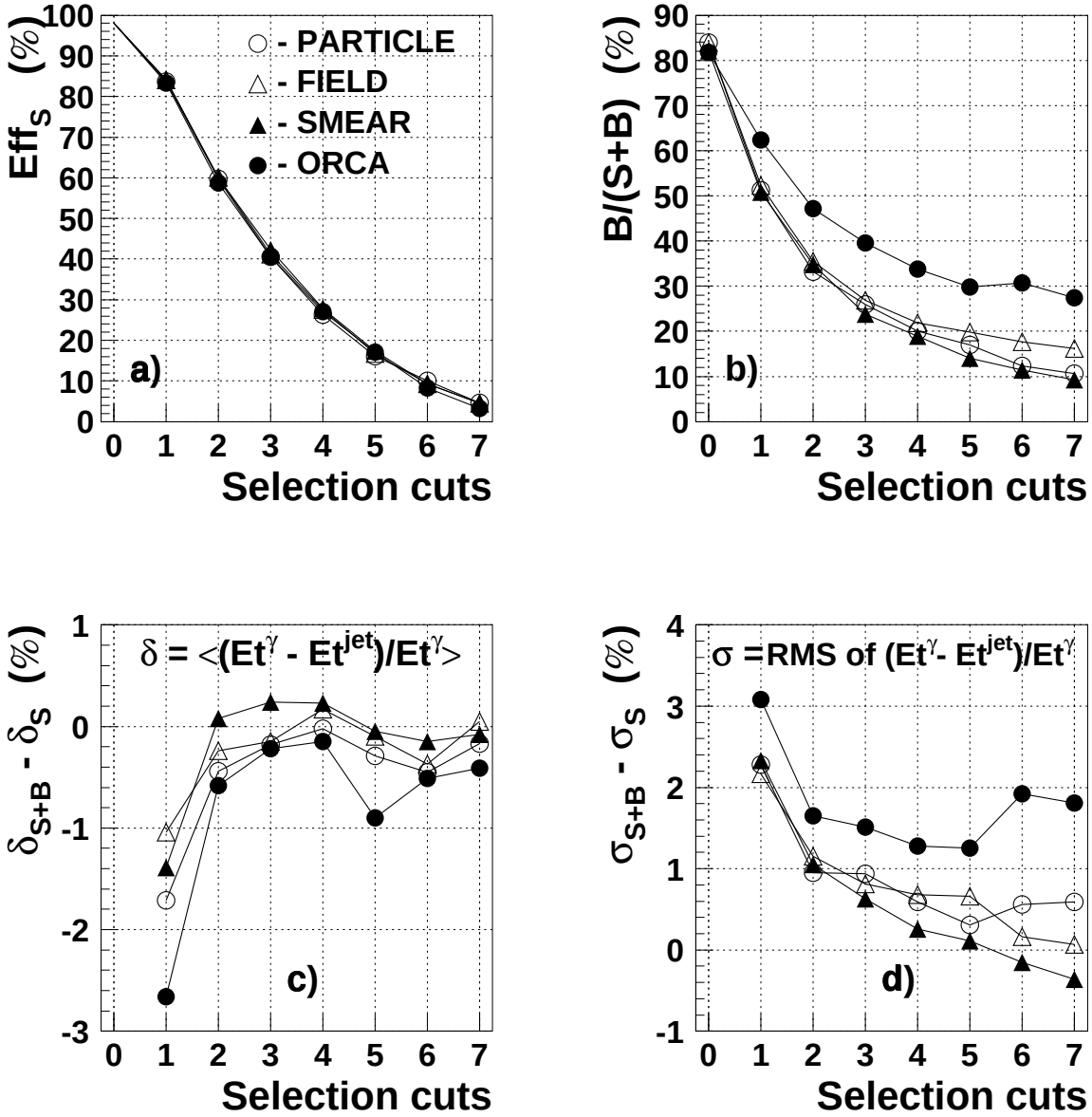
Selection cuts	1 (Eff$_S$=83%)	...	7 (Eff$_S$=5%)
$\mathbf{Et}_{\gamma}^{isol}$ max (GeV)	12	...	4
$(180^o - \Delta\phi^o)$ max	38	...	15
$\mathbf{Et}^{jet2}$ max (GeV)	40	...	15
$\mathbf{Et}^{out}$ max (GeV)	41	...	10

Case $20 < Et^{\gamma} < 40GeV$.



The background at ORCA-level is equal about 60% for hard cuts (4-7) (instead 30% without noise (fig.b)). However, starting with 3-4 cuts the background leads to systematic errors of a calibration <1% (fig.c) and statistic errors $< 2\%$ (fig.d). At the same time signal is suppressed in to 3 times (fig.a).

Case $40 < Et^{\gamma} < 100GeV$.



For higher Et$^{\gamma}$ the situation with background is much better. In case ORCA we have at cut 4:

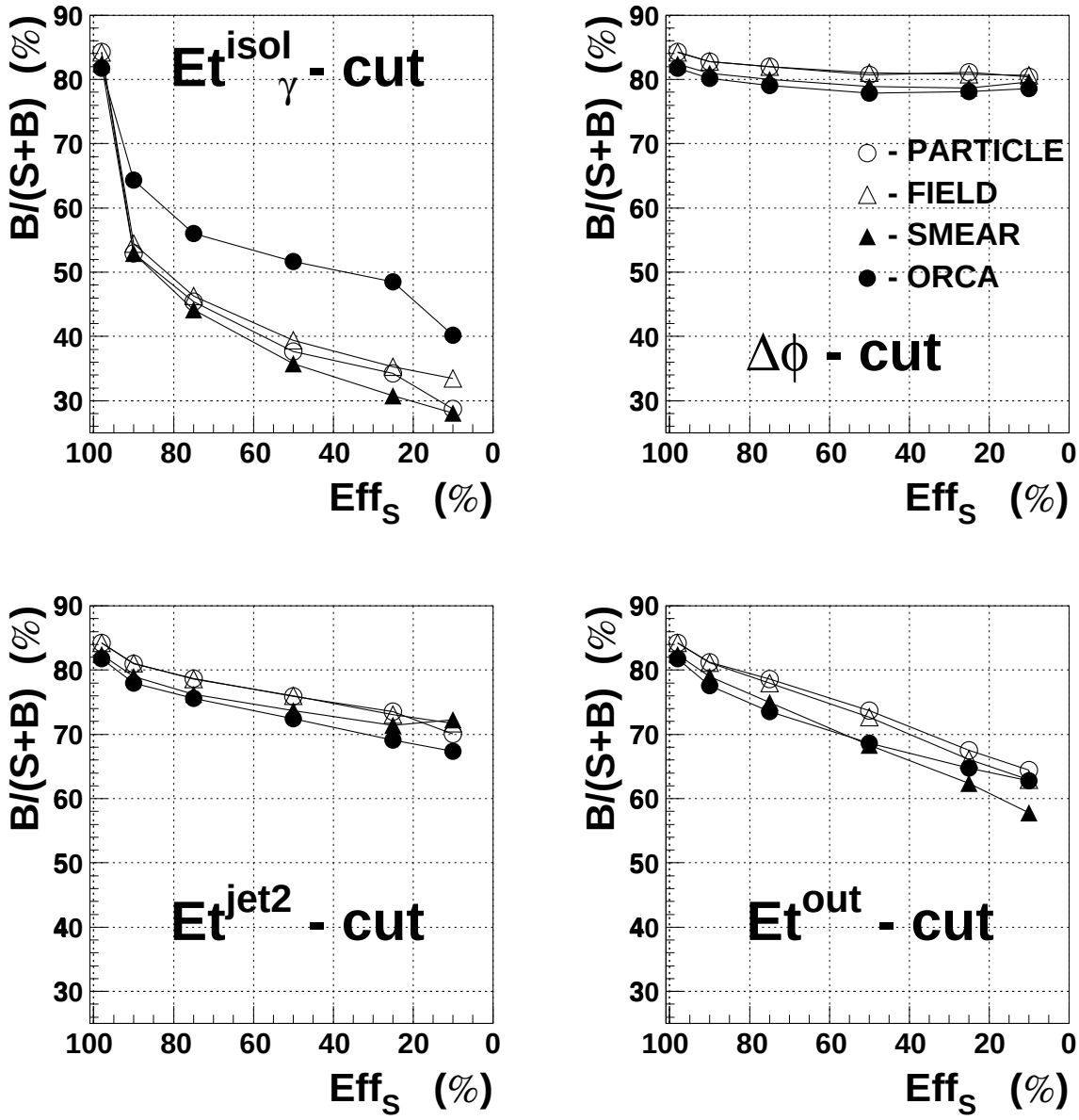
part of background $\approx 30\%$ (fig. b)

and at cut 2 (Eff$_S$=60%):

systematical error <1% (fig. c)

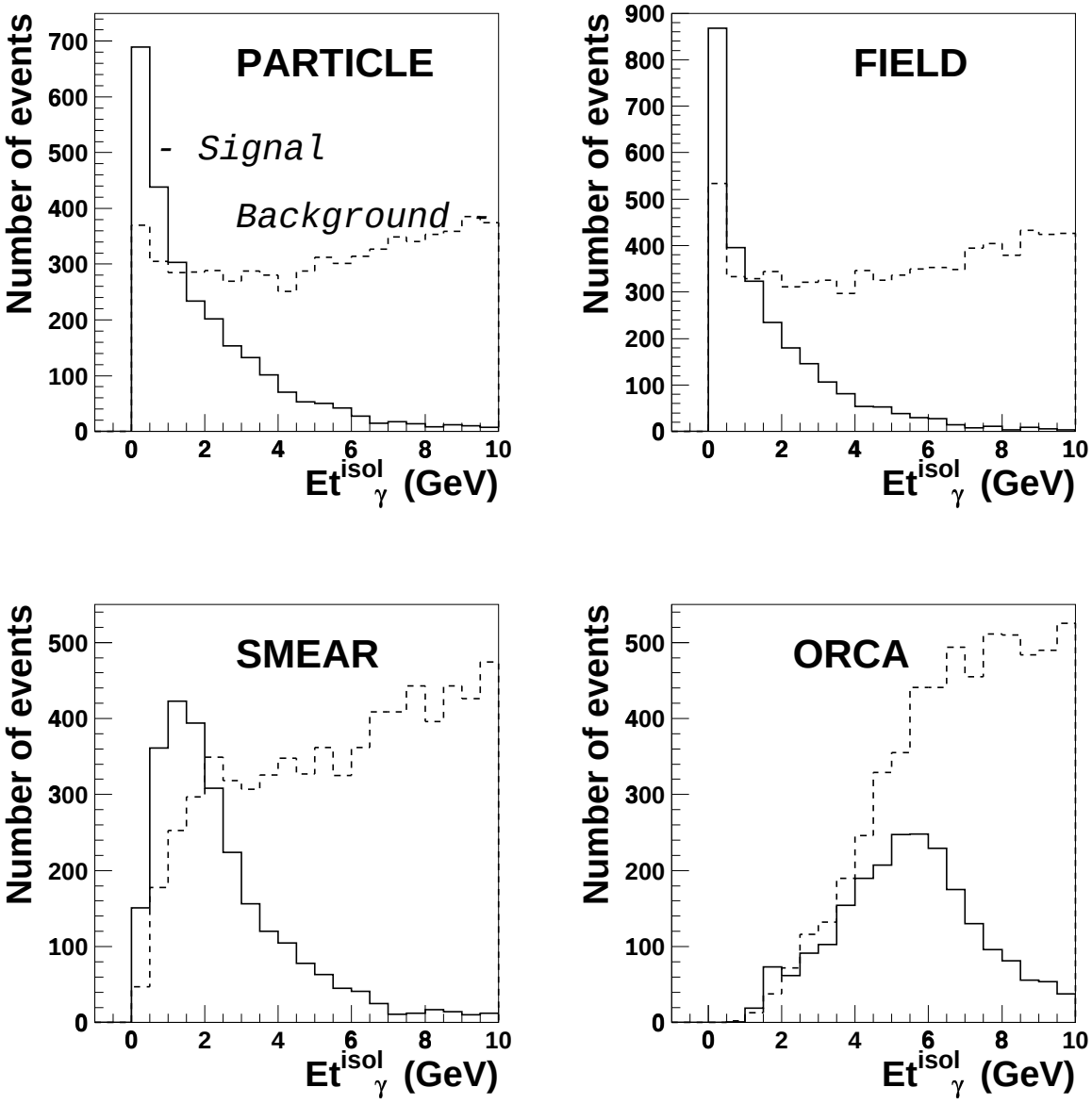
and statistic error <2% (fig. d).

Case $40 < Et^{\gamma} < 100GeV$.

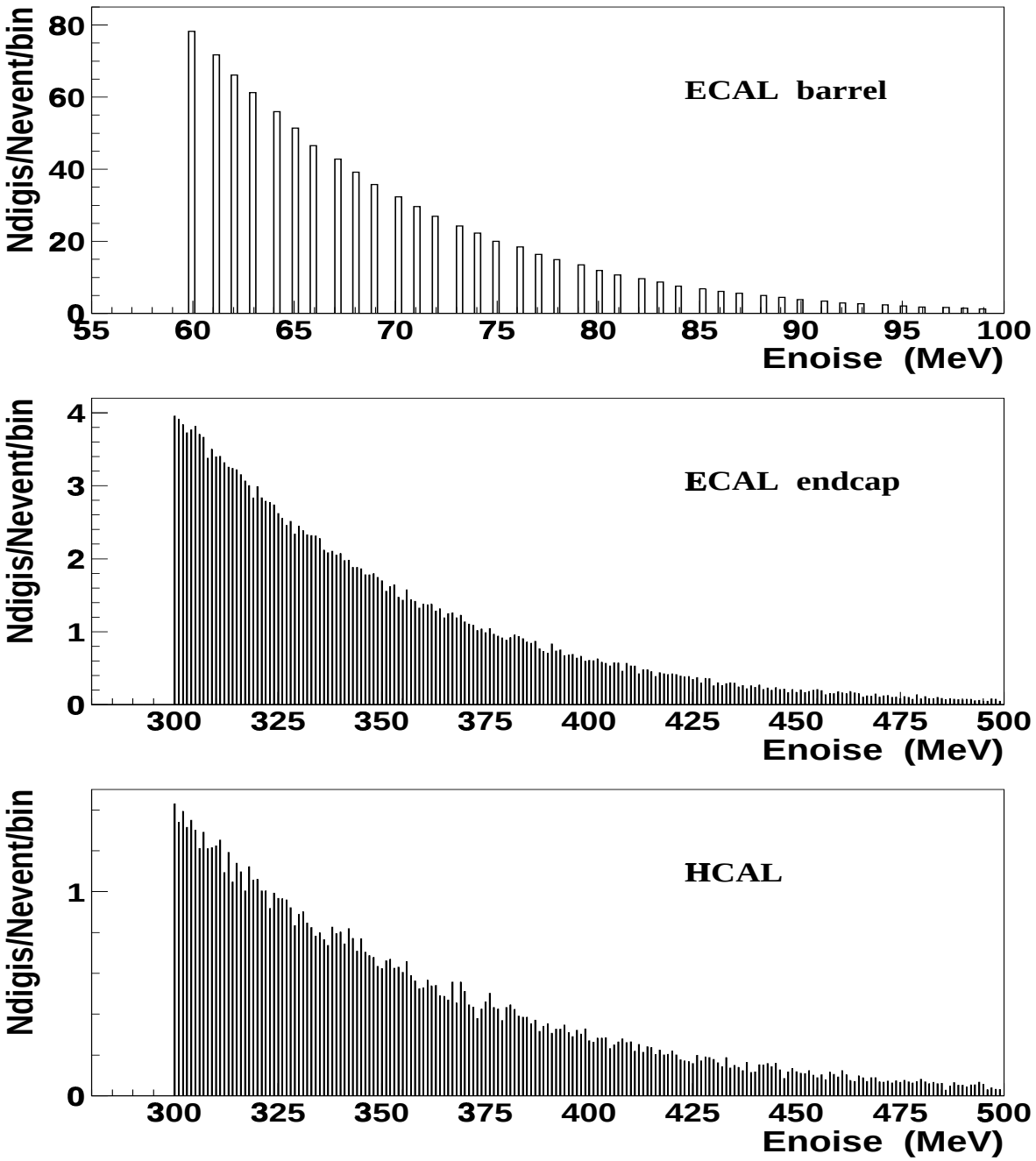


We can to reduce a part of the background in the selected events by using $\mathbf{Et}^{isol}_{\gamma}$, $\Delta\phi$, $\mathbf{Et}^{jet2}$ and $\mathbf{Et}^{out}$ cuts. $\Delta\phi$, $\mathbf{Et}^{jet2}$, $\mathbf{Et}^{out}$ suppress the background at **PARTICLE**, **FIELD**, **SMEAR**, **ORCA** levels equaly. But background suppression at ORCA-level by $\mathbf{Et}^{isol}_{\gamma}$ -cut worked worsely.

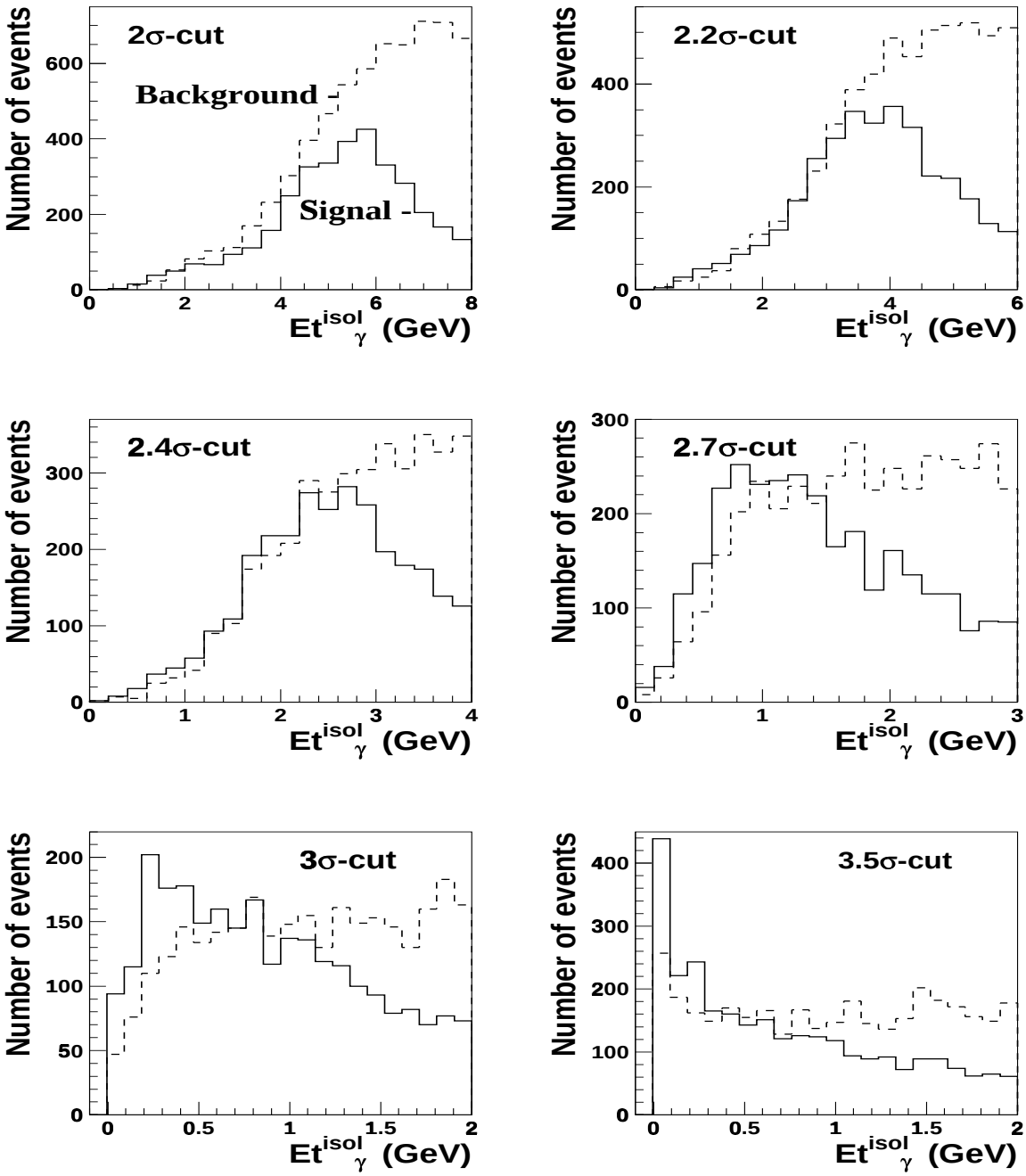
Case $40 < Et^{\gamma} < 100GeV$.



The $\mathbf{Et}_{\gamma}^{isol}$ distributions for both signal and background at PARTICLE, FIELD, SMEAR and ORCA levels are presented here. We can see that the signal and background separation is not good at ORCA level. This fact is the main sourse of the degradation of situation with background at the ORCA level.

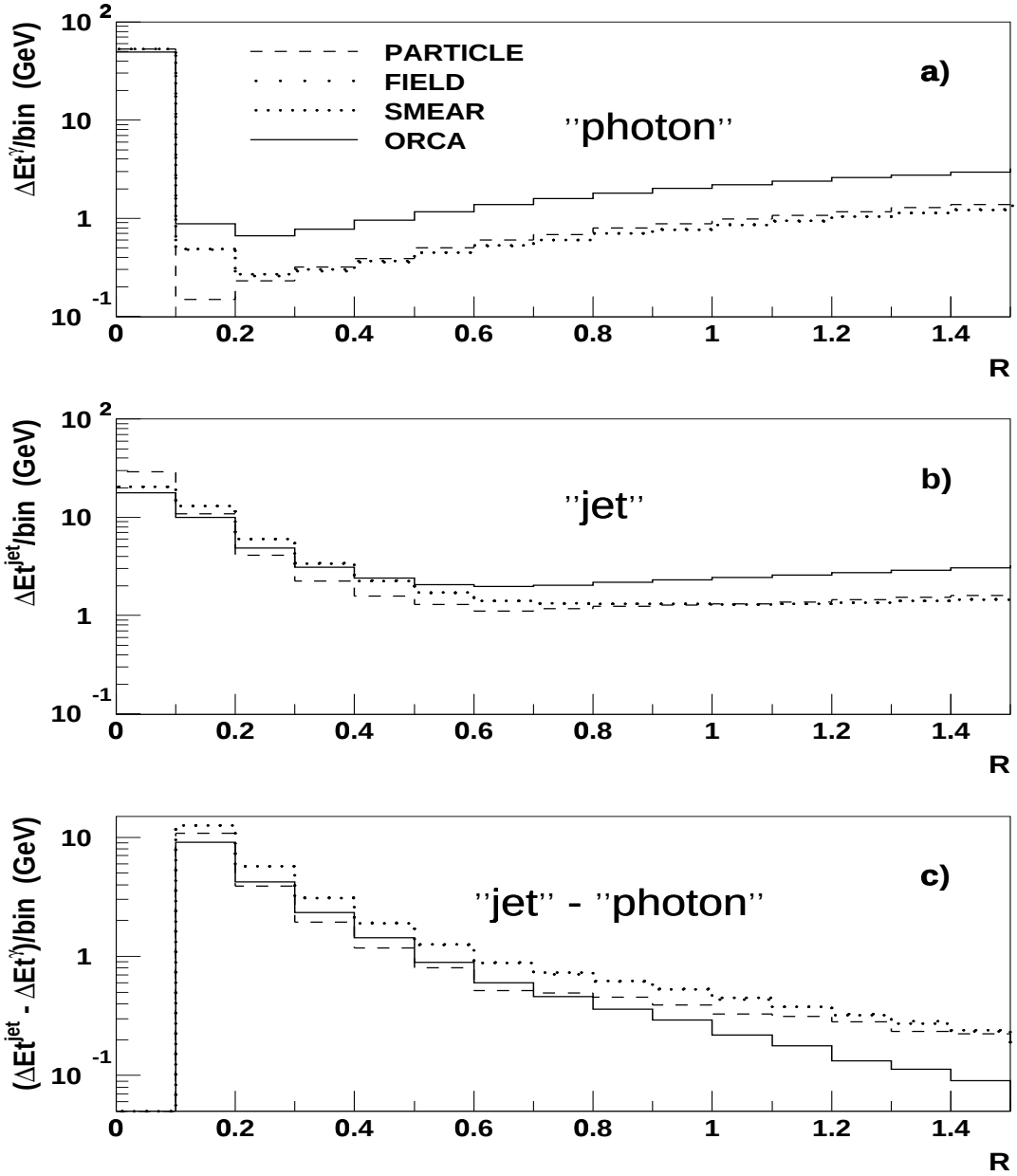


Distributions of the E noise in the cells of EB, EE and HCAL after to 2σ cuts.



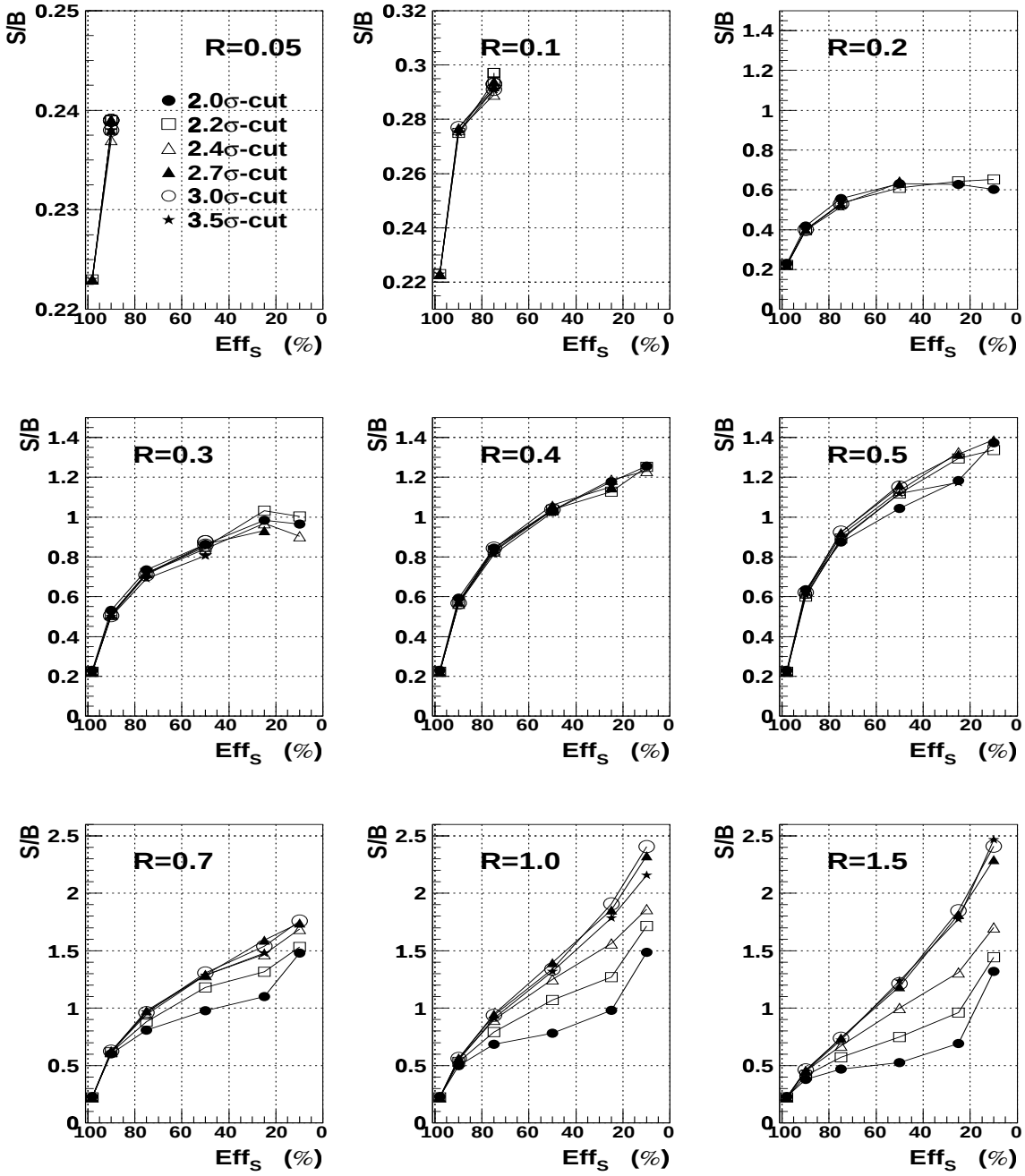
The $\mathbf{Et}_{\gamma}^{isol}$ distributions for both signal and background at ORCA levels with different cuts of the E noise. We can see that the signal and background separation is incoming a good at 3σ cut.

Case $40 < Et^{\gamma} < 100GeV$.



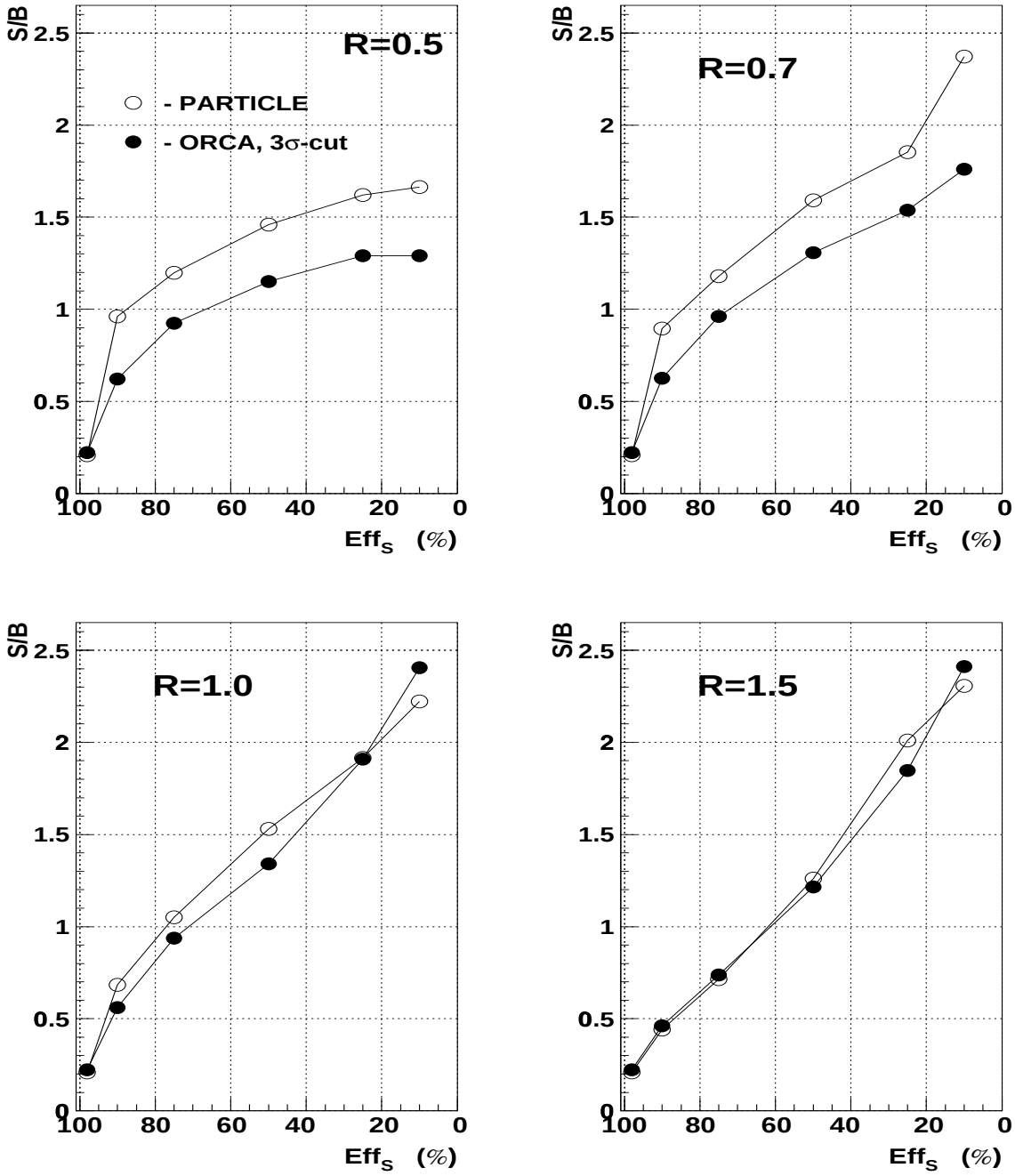
An average value of the δEt^{γ} and δEt^{jet} at the ring around of the direct photon (a) and jets (b). And the difference $\delta Et^{jet} - \delta Et^{\gamma}$. Jets is shown over $R = 1.5$.

Case $40 < Et < 100GeV$:



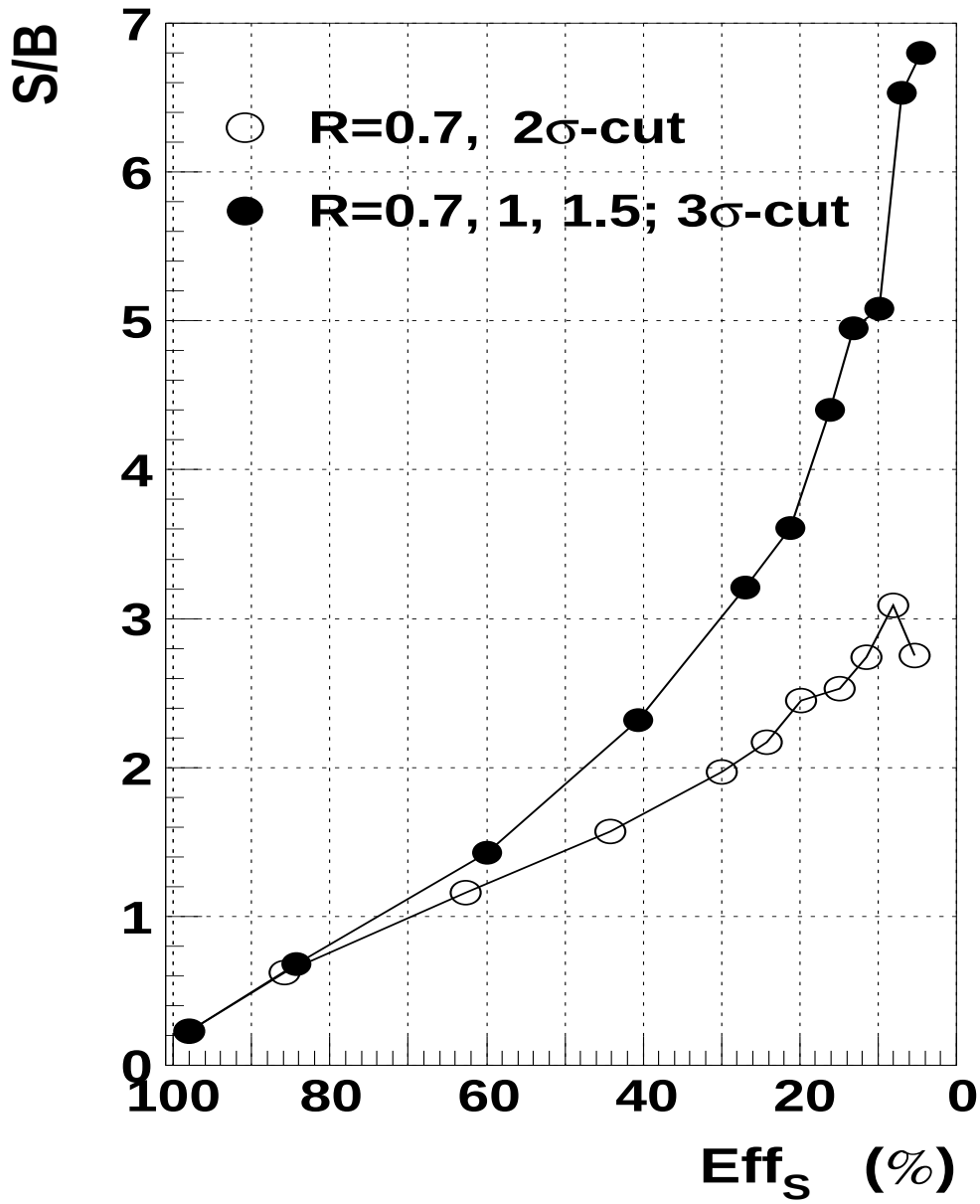
Eff_S dependens of S/B for different R_{isol} and E_{noise} cuts. A more suppression of the background we are getting at $0.7 < R_{isol} < 1.5$.

Case $40 < Et < 100GeV$:



Eff_S dependens of S/B for different R_{isol}. $PARTICLE$-level and $ORCA$-level (3σ cut). A more suppression of the background we are getting at $0.7 < R_{isol} < 1.5$.

Case $40 < Et^{\gamma} < 100GeV$.



Used cuts $R_{isol} = 0.7,\ 1.,\ 1.5$ and 3σ-cuts is improving of S/B fraction value approximatly 2 times (ORCA level).

Next step of the background study is taking in to account

- pile-up,
- γ-trigger,
- π^0 rejection.