SSC-SDE-9

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SOLENOIDAL DETECTOR NOTES

ELECTRON ID RELATED TOPICS IN HIGGS->ZZ, Z->e+e-
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Electron ID related topics in Higgs -> ZZ, Z->e+e-

(all results are preliminary and analysis is still going on, may be forever)

1) Dead regions vs Efficiency

How dead regions (particle cannot be detected or electron cannot be identified) affect the efficiency of detecting 4 leptons coming from the Higgs decay (purely geometrical).

Higgs mass = 400 GeV, Top quark = 140 GeV, Radius = 1.6m

Fig.1 shows the efficiency as a function of maximum η coverage.

Fig.2 shows the effects of dead regions. The dead regions come from the Martin Marietta study. 8% dead region in ϕ corresponds to ±1cm dead regions at the boundaries of 40 modules.

In the rapidity region of $|\eta| < 2.5$, the efficiency drops down by factor of 2 due to the dead regions. One may not be able to use 3 well identified electrons + 1 track in these dead regions to gain the efficiency, because the background from $t\bar{t}$ events (2 electrons + 2 hadrons or 3 electons + 1 hadron) is much larger than the signal.

Using masses shown above, one expects to observe ~40 Higgs signal by 4 electron modes with the efficiency of ~30%. But, this does not include any efficiencies due to the software selections, either to select high purity electrons or to reduce backgrounds. If these efficiencies are 90%, the total efficiency drops down to 20%. It is necessary to use μ as well to enhance the statistics.

With the top quark mass of 40 GeV, the Higgs production rate is around 1/4 of this estimation, i.e., ~10 Higgs->4 electrons / year.

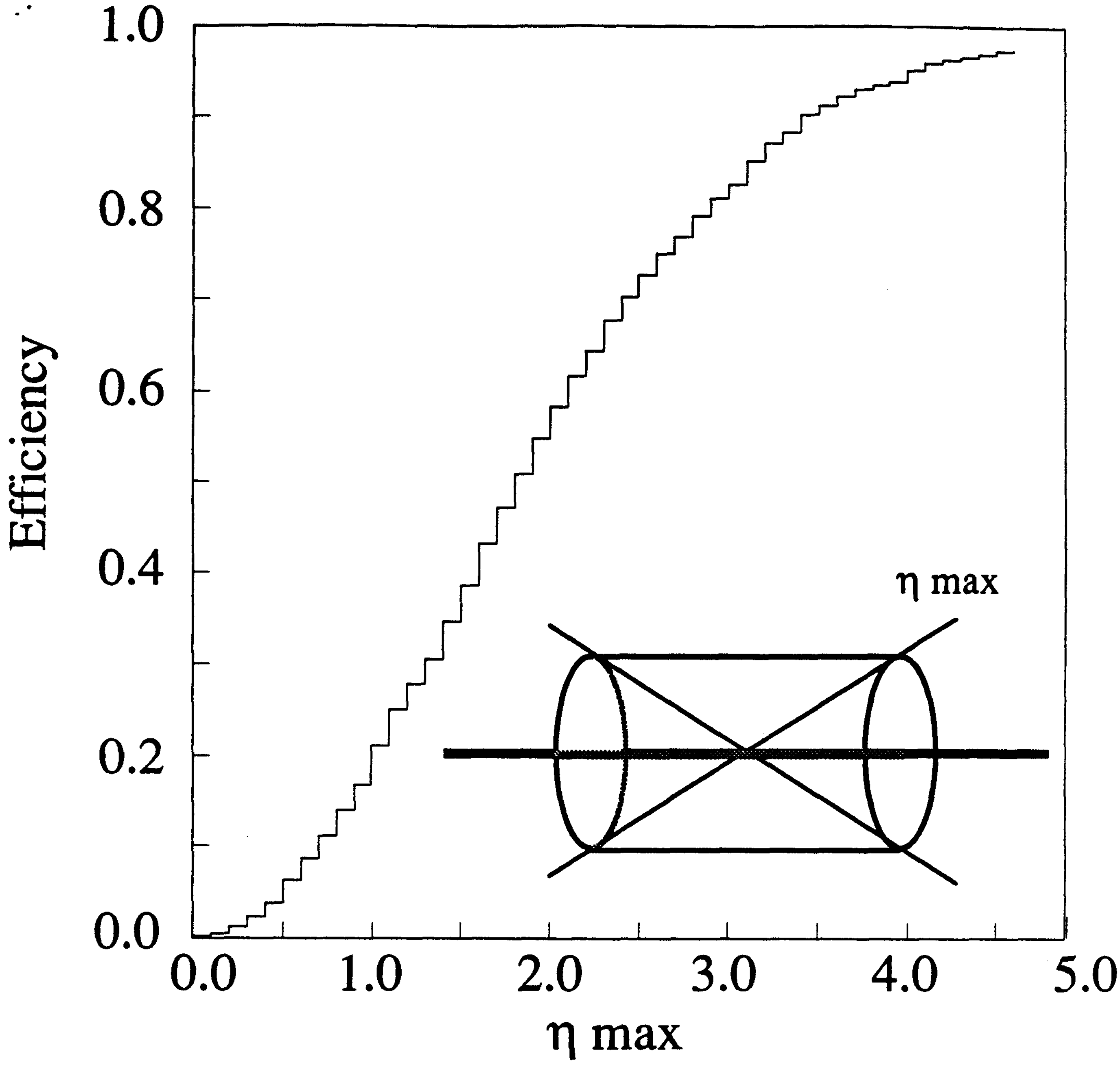


Fig. 1 Efficiency vs η coverage

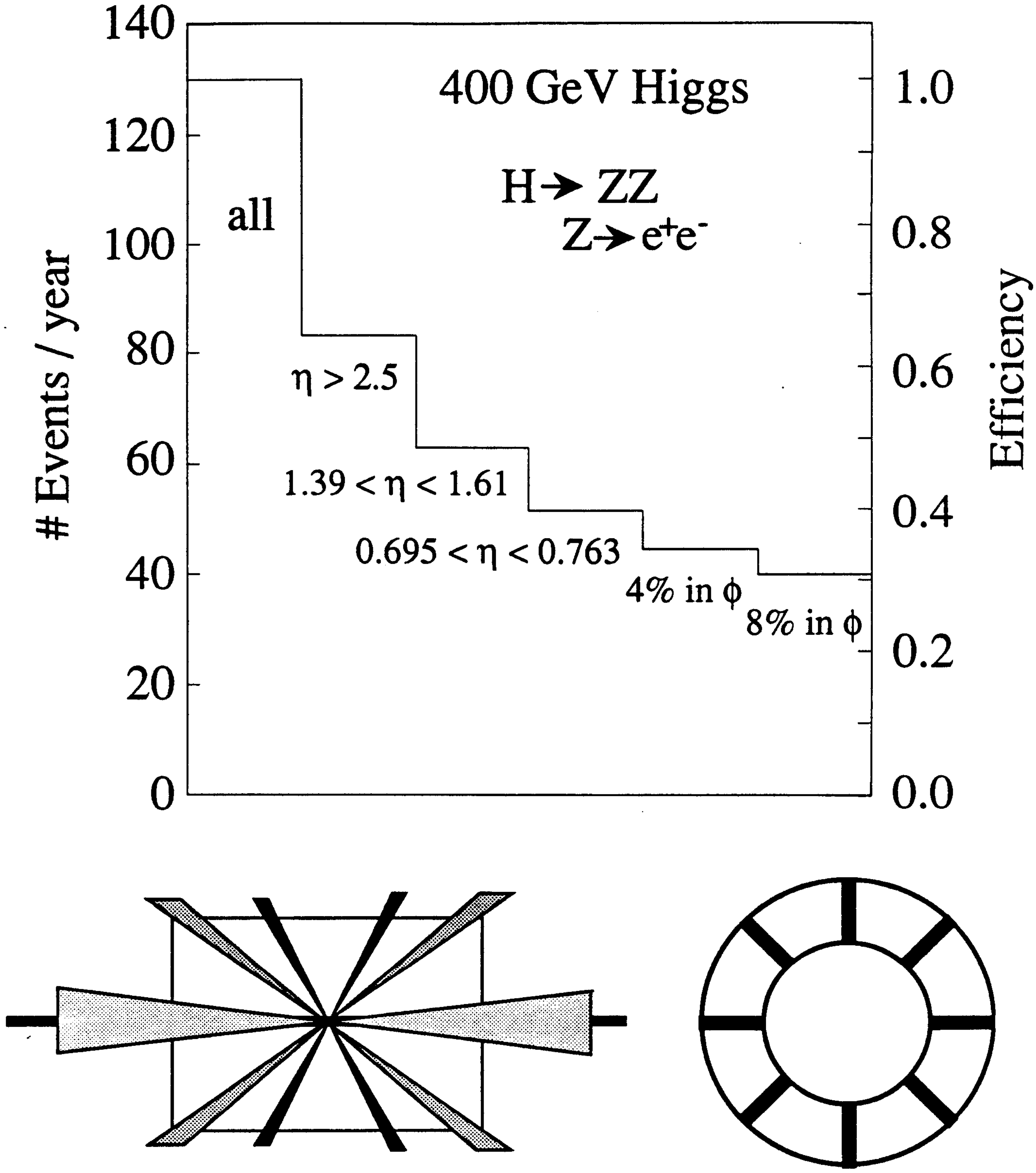


Fig. 2 Dead region effect on efficiency

2) $\pi - \gamma$ overlapping and B-field

How often charged π and γ overlap (these are the most serious backgrounds to the electron signal), and what is the effect of the magnetic field.

400 GeV Higgs, Top quark = 140 GeV, Radius = 1.6 m

A cluster is defined to be a charged π and photons, if there were any, which hit the cylindrical detector within 2cm around the charged track.

Fig.3 shows the distribution as a functions of $R\gamma = E\gamma / (E\pi + E\gamma)$ with (20KG, dashed line) and without (solid line) magnetic field. $R\gamma \approx 0$ corresponds to "high momentum π with low momentum γ" and $R\gamma \approx 1$ to "low momentum π with high momentum γ". The process generated is QCD jets with Qt > 400 GeV. Fig. 3(a) is the distribution of low energy ($E\pi + E\gamma$ = 20-50 GeV) clusters , and Fig. 3(b) is that of high energy ($E\pi + E\gamma > 50$ GeV) clusters. Fig. 3(c) and (d) show the ratios of the distributions with and without magnetic fields.

Magnetic field reduces the background due to the π γ overlapping by factor of 5 or more for those cases with $R\gamma \approx 1$ by spreading the charged track shower. These background can be further reduced by the E-p matching requirement. The opposite region, $R\gamma \approx 0$, will be rejected by the energy deposits in the EM and hadron calorimeter.

Fig. 4 shows the same plot of high momentum cluster ($E\pi + E\gamma > 50$ GeV) in $t\bar{t}$ events, with addition isolation requirement, Et ($\Delta R < 0.3$) < 4 GeV. In total of 50K events were generated, and 700 tracks passed this isolation cut, ~1%. The cross section is 1.5×10^4pb, i.e., 1.5×10^8/year. (Remember, 140Higgs->4 electrons / year !!!). 20 πs with γ around passed this cut.

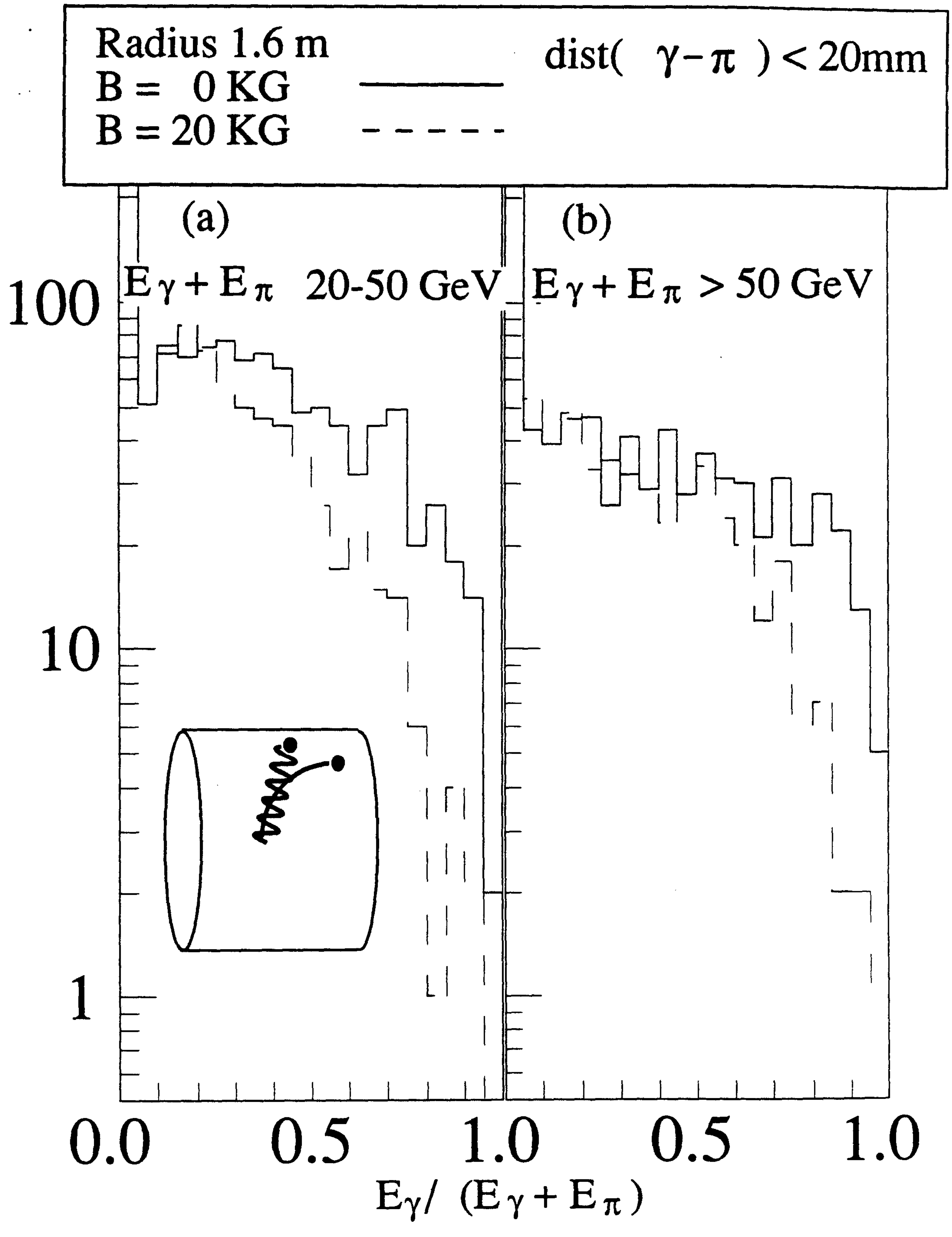
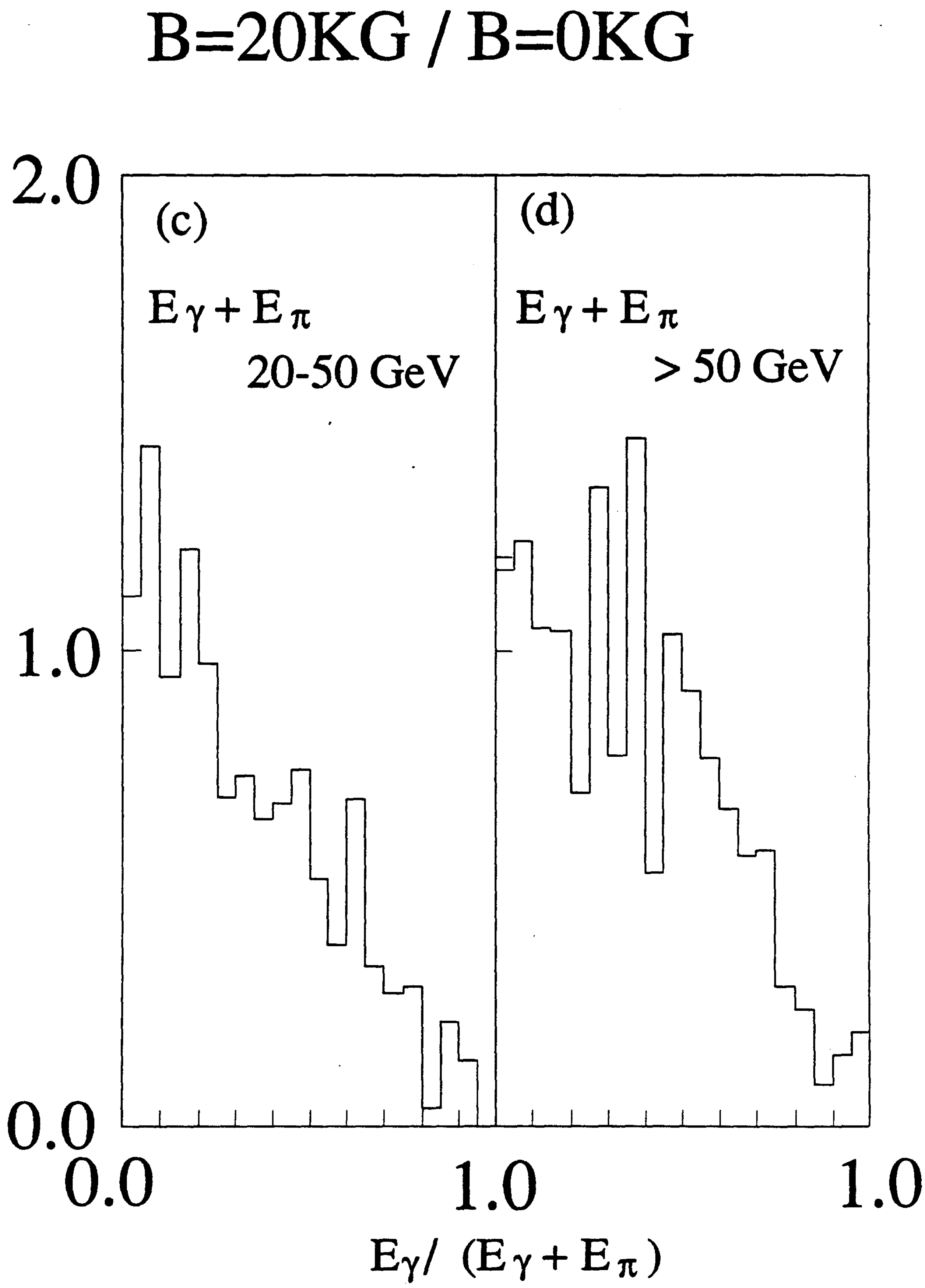


Fig. 3 π-γ overlapping & B-field



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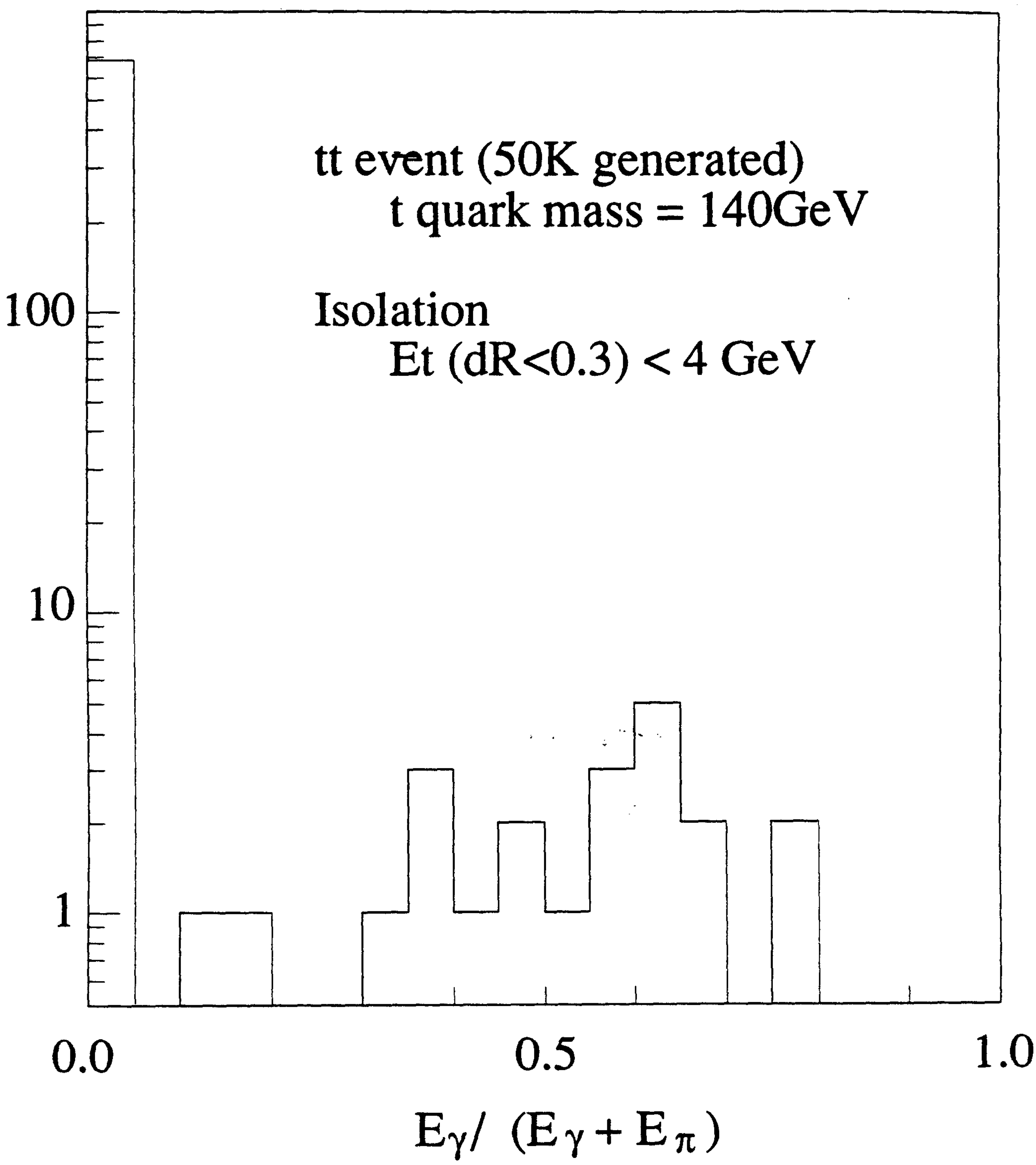


Fig. 4 π-γ overlapping in $t\bar{t}$ events

3) Background study for Goldplate signal
Higgs -> ZZ, Z->e+e-

Purpose

Study the requirements on the detector capabilities to detect the goldplate events, segmentation, charge and electron identification.

Events studied

(Z -> e^+e^- 100 %, Higgs = 300 GeV, Top = 60 GeV)

Higgs production			PYTHIA 4.9
$q\bar{q}$	->	H	15 %
gg	->	H	61 %
ZZ	->	H	8 %
WW	->	H	15 %
$q\bar{q}$	->	H + Z	0 %
$q\bar{q}$	->	H + W	0.6 %

Backgrounds

ZZ	PYTHIA
$t\bar{t}$ Z	PAPAGENO + PYTHIA
Z + jets	PYTHIA
qg -> Z + q	92 %
q q -> Z + g	7 %

Pure QCD events (no Z's)

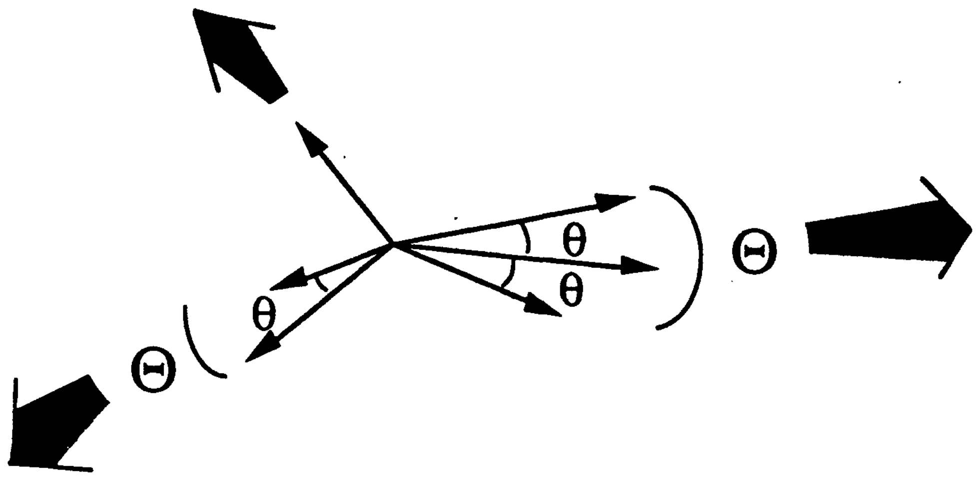
main backgrounds come from leptonic decays of heavy quarks

Track and event selections

Tracks used : Pt > 10 GeV, | η | < 2.5

Events used : # tracks >= 4

Clustering or simple segmentation



combine tracks with θ < resolution

Resolution for π^0/γ σ_γ = 30 mr

charged σ_{ch} = 50 mr

Slim cluster : cone size Θ < resolution

== single isolated cell is fired

Fat cluster : cone size Θ > resolution

== several contiguous cells fired

Isolation of clusters to reduce tracks in jets

Minimum opening angle between the cluster and all other clusters. Isolated cluster : $\Theta_{min} \geq 0.2$

Fig. 5. Minimum opening angle between a slim cluster and other tracks in different kinds of events

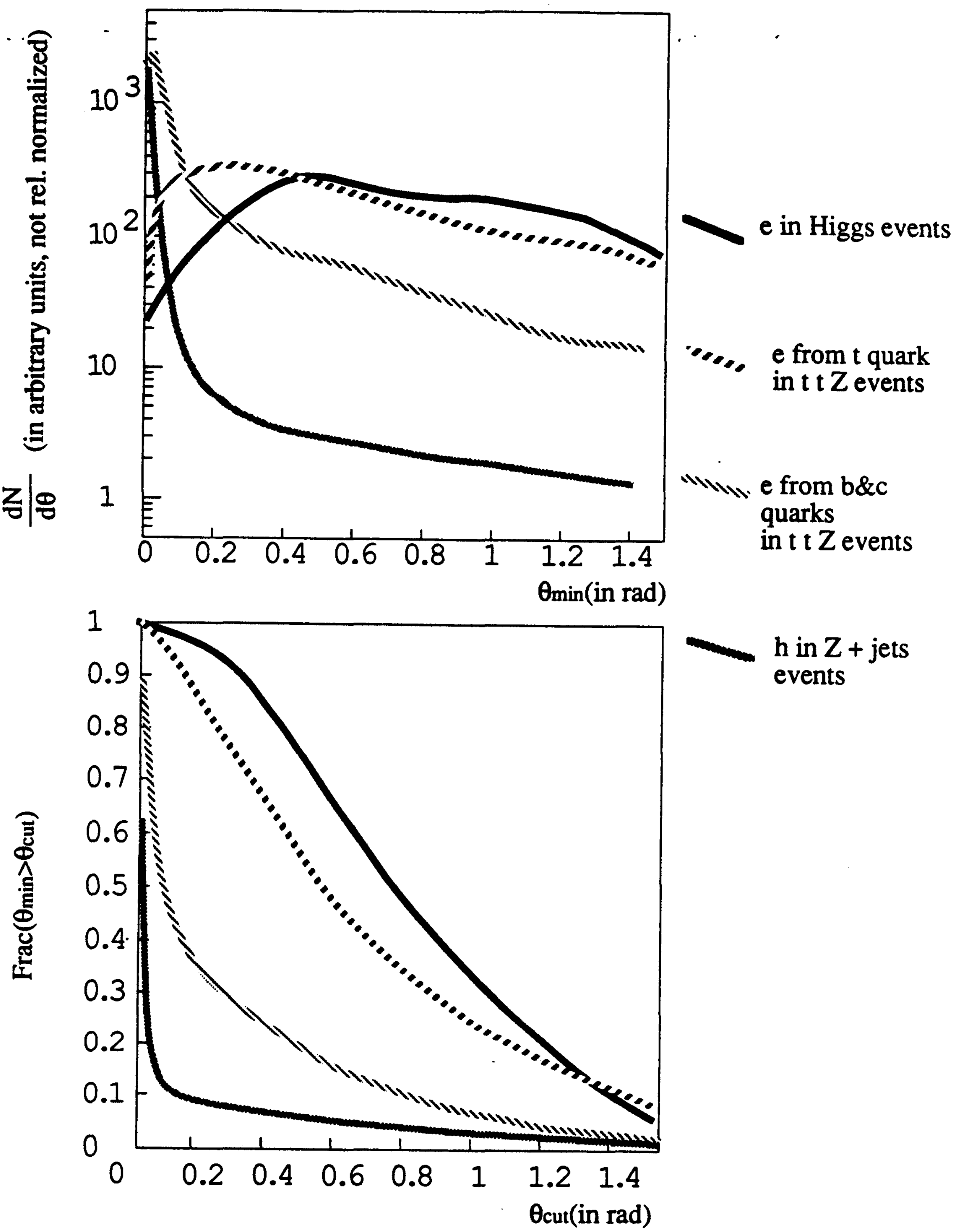


Fig. 5 Minimum opening angle between a slim cluster and others clusters

Z	:	a pair of slim clusters with Pt > 30 GeV Mass = Z mass ± 10 GeV
Good Z	:	two Isolated clusters

Higgs / $t\bar{t}$Z / ZZ pair / Z jets / pure QCD

ZZ elem.	ZZ pair	Good ZZ pair
HH-HH	16K+7B 1 / 1K / 0 /15K / 7B	0 + 47M 0 / 2 / 0 / 0 / 47M
HH-EH	70K+200M 8 / 2K / 0 / 68K/ 200M	0.9K+13M 0 / 40 / 0 / 860 / 13M
EH-EH	46K+1000K 25 / 728 / 3 / 45K / 1M	2.6K+300K 3 / 97 / 0 / 2.5K / 0.3M
EE-HH	74K+1000K 10 / 280 / 1 / 74K / 1M	6.5K+300K 2 / 31 / 0 / 6.5K / 0.3M
EH-EE	3.7K+100K 62 / 131 / 19 / 3.5K / 100K	0.8K+10K? 22 / 33 / 9 / 761 / 10K?
EE-EE	136+?? 64 / 10 / 62 / 0 / ??	121+?? 58 / 6 / 57 / 0 / ??
Z - Z	121 61 / 0 / 60 / 0	112 56 / 0 / 56 / 0

E : Cluster with electon, H : Cluster without electron

Fig. 6 : Fractions of different kinds of 'ZZ" candidates with different electron ID probability.

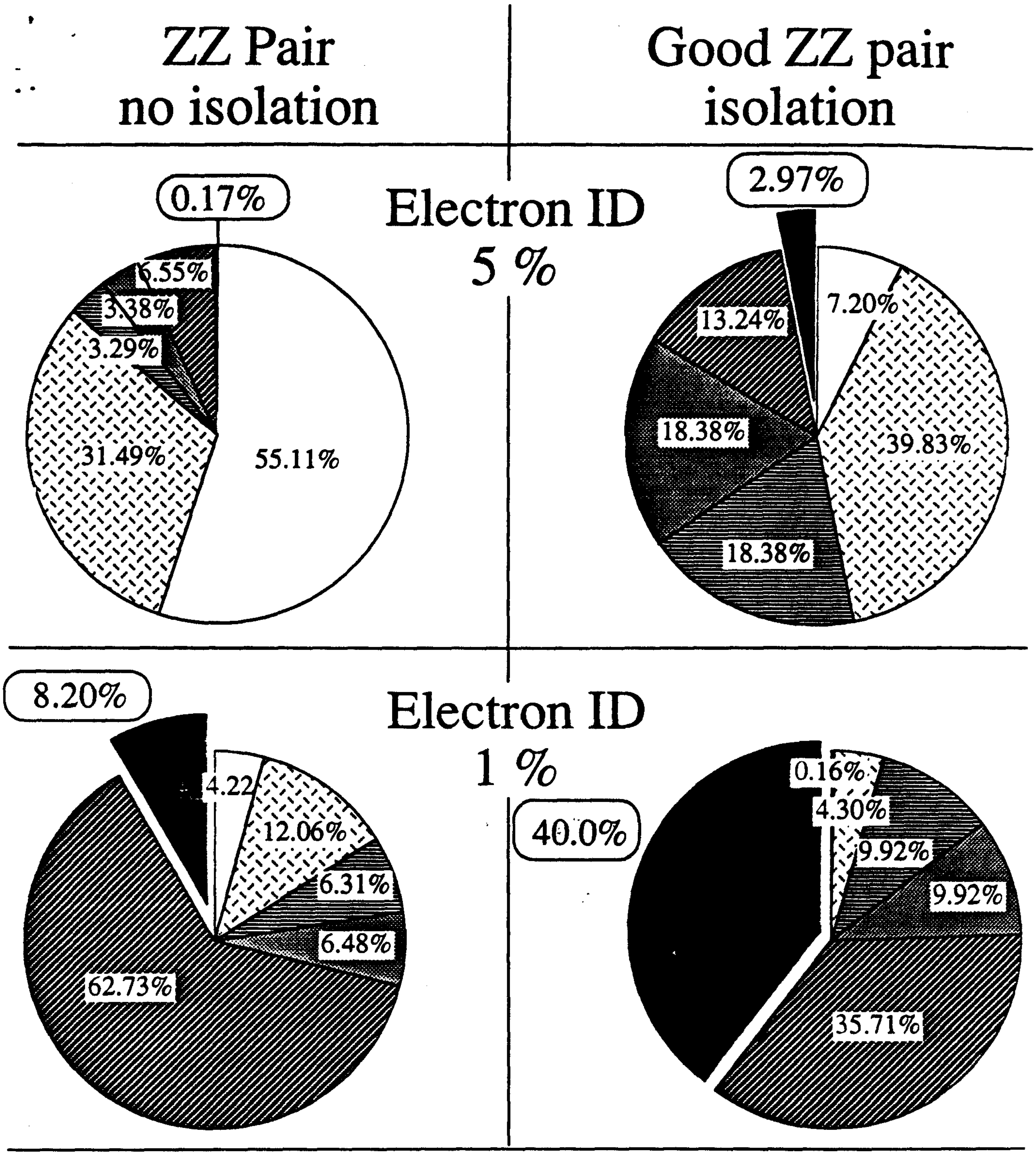


Fig. 6 Fractions of different kinds of "ZZ" candidates with/without isolation and with different electron ID.