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H1 integrated luminosity using QED Compton events July-August 1993

A.Courau and S.Kermiche.
Laboratoire de l'Accélérateur Linéaire, IN2P3-CNRS
et Université de Paris-Sud, F-91405 Orsay Cédex, France.

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Abstract

We report on QED-Compton events selected from July-August 1993 H1 runs. We found about 100 events, mostly with the two clusters in the BEMC, 17 events with a cluster in the liquid Argon calorimeter and the other in the BEMC. Thereby we derived an Integrated luminosity on the BEMC of :

$$\mathcal{L} = 110 \pm 12 \text{ nb}^{-1}$$
with
$$\mathcal{L} = 108 \pm 12 \text{ nb}^{-1} \text{ for } (54000 \leq Run \leq 60626)$$

Let us notice that we have 2 QED-Compton candidates with the two clusters in the liquid Argon.

Introduction :

We have analysed QED-Compton events coresponding to the July-August 1993 H1 runs ($50147 \leq Run \leq 60626$). Thereby we have optimized the calibration of the energy and position of the BEMC clusters. This analysis and the results we got are separately reported in a another note[1], but taken into account here, where the particle energies (hitting the BEMC) are obtained by mutiplying the BCLR energies by a factor of 1.05. The (x,y) position of the BEMC cluster reconstructed in a triangular stack is also corrected according to this study [1].

1 Events used in this analysis :

We have analysed events in the DST1 (files "HERA03.H1DST1.C9302...") of QEDCOM class (class 12 - bit 5) which we have created (and tested !) especially for this kind of events. The monte carlo sample was obtained by generating a number of events equivalent to a luminosity of 1420 pb^{-1} with the generator COMPTON 2.00[2, 3]. The simulation of this sample of events was done by H1SIM 2.13/01 with "FAST" option. Finally we reconstructed these events with H1REC 3.10 .

2 Event selection :

The selection criteria of events are derived from data themselves and compared with the monte carlo expectations.

In this analysis we essentially have used the information from the shower radius R_{cl}, the energy and the position of the clusters (the clusters are ordered by decreasing energy : $E_{cl1} \geq E_{cl2}$).

Let us remind that the QED-Compton events are overdominated by the scattering of a quasi-real photon with the incident electron giving a final state caracterised by [4, 5]:

- Two small radius of shower R_{cl} (caracterising "electromagnetic" particles).
- A visible energy relatively close to the incident electron energy [1]

$$E_{vis} = E_{cl1} + E_{cl2} \simeq E_{ein}$$

- A coplanarity angle $\Delta\varphi = |\varphi_1 - \varphi_2|$ close to π.

[1] Of course this caracteristic concerns only the case of small invariant mass where the two clusters are in the BEMC area.

- Two constraints (between angles and energies) leading to the relations :

$$E_{cl1}(\Theta_{cl1},\Theta_{cl2}) = \frac{2E_{ei}sin(\Theta_{cl2})}{sin(\Theta_{cl1})+sin(\Theta_{cl2})+sin(\Theta_{cl1}+\Theta_{cl2})} \quad (1)$$

$$E_{cl2}(\Theta_{cl1},\Theta_{cl2}) = \frac{2E_{ei}sin(\Theta_{cl1})}{sin(\Theta_{cl1})+sin(\Theta_{cl2})+sin(\Theta_{cl1}+\Theta_{cl2})} \quad (2)$$

First of all, looking at the main distributions as E_{vis}, the cluster radius R_{cl}, $\Delta\varphi$ and also the number of the BPC hits, one notice (figure 1) that runs below 54000 are especially noisy (small E_{vis} , large shower radius R_{cl2} and flat $\Delta\varphi$ distribution) and without BPC hits. We observe the same thing for runs around 60000. This is particularly obvious in the E_{vis}/R_{cl2} correlations : see in figure 2 the comparison between various run periods and monte carlo.

Now looking at the R_{cl} distributions (figure 3) one observes a peak of good "electromagnetic" shower rather similar to the monte carlo prediction, with mainly for the second cluster , a "hadronic" tail. In Selecting events with $R_{cl} \geq 4$ cm, one selects events with flat coplanarity distribution and small visible energy corresponding to background events.

Thus, for events with "good" showers, we got for the radius of the shower [2] an RMS of 0.7 cm around a mean value of 1.3 cm, values which agree with the monte carlo ones. Therefore we built, for the BEMC clusters, an "electromagnetic" shower identificator defined by :

$$ID_R = \frac{R_{cl}-1.3}{0.7}$$

Now we compute the energies of the two clusters, from polar angles, according to equations (1) and (2) and define another identificator (caractérising QED-Compton events) :

$$ID_E = \frac{E_{cl}(\Theta)-E_{cl}}{0.3\sqrt{E_{cl}(\Theta)}}$$

The $\sqrt{E}$ expression of the error and the 0.3 factor have been determined from data (for more details see the note on the calibration[1]).

From these two identificators we defined a "pseudo" χ^2 of the event :

$$\chi^2 = \sum_{i=1}^{2}\left(\left(\frac{R_{cli}-1.3}{0.7}\right)^2 + \left(\frac{E_{cli}(\Theta)-E_{cli}}{0.3\sqrt{E_{cli}(\Theta)}}\right)^2\right)$$

The distributions of this χ^2 from data and monte carlo are shown in figure 4. The figure 5 shows the correlations between ID_R and ID_E for the event cluster having the largest $ID_R^2+ID_E^2$, from accepted and rejected events within a χ^2 cut : $\chi^2 \leq \chi_0^2$ ($\chi_0^2 = 12$ as an example).

[2] These values are different from the ones we found for the liquid Argon showers.

3 Integrated Luminosity measurement :

Within the χ^2 cut at $\chi^2_0 = 12$, we select 1033 events from the 1420 pb$^-$1 of the monte carlo, and 78 events from data . This leads to an integrated luminosity on the BEMC [3] of :

$$\mathcal{L} = 107 \pm 12 \text{ nb}^{-1} \text{ for } (54000 \leq Run \leq 60626)$$

This result is obtained using only events with both clusters in the BEMC. Actually we also have 17 events with one cluster in the BEMC and the other in the liquid Argon calorimeter (while the monte carlo predicts 215 events for 1420 pb^{-1}). Including these events, one obtain an integrated luminosity of :

$$\mathcal{L} = 108 \pm 12 \text{ nb}^{-1}$$

Let us notice that we have 2 candidates which have the two clusters in the liquid Argon (figure 7) .

In order to study the systematical errors we studied the influence of the "χ^2" cut on data and monte carlo events in the case where the two clusters are in the BEMC.

The results, for the values of this cut varying from $\chi^2_0 = 8$ to $\chi^2_0 = 16$, are shown in the figure 7. We see that the ratio of monte carlo and data number of events remains practically constant and then the value of the integrated luminosity.

Figure 8 shows the number of events and the corresponding integrated luminosity for different configurations of the two clusters within the detector. The difference on luminosity coming from these different configurations ($\simeq$ 3%) is within the statistical error.

Figures 9 shows the comparison between the data and monte carlo for the distribution of various event quantities : visible energy E_{vis}, the invariant mass of the $(e-\gamma)$ system $W_{e\gamma}$ and the coplanarity angle $\Delta\varphi$. We see the quite good agreement between data and monte carlo.

References

[1] "BEMC calibration using QED Compton events : July-August 1993 period" , H1 note in preparation.

[3] As we said at the begining runs before 54000 are noisy and not efficient, but if we include them we got only 2 Compton events giving a small increase of the luminosity :

$$\mathcal{L} = 110 \pm 12 \text{ nb}^{-1} \text{ for } (50147 \leq Run \leq 60626)$$

[2] "Quasi-real QED Compton monte carlo " T.Carli,A.Courau, S.Kermiche, and P.Kessler . Proceedings of the HERA wrkshop. Hamburg, October 1991 (volume 3- p.1468).

[3] A.Courau and P.Kessler, Physical review D46 1(1992) 117-124.

[4] "QED Compton events in H1 : Luminosity measurements and BEMC calibration studies" A.Courau and S.Kermiche . H1NOTE 12/92.260

[5] A.Courau and P.Kessler, Physical review D33 (1986) 2024-2028.

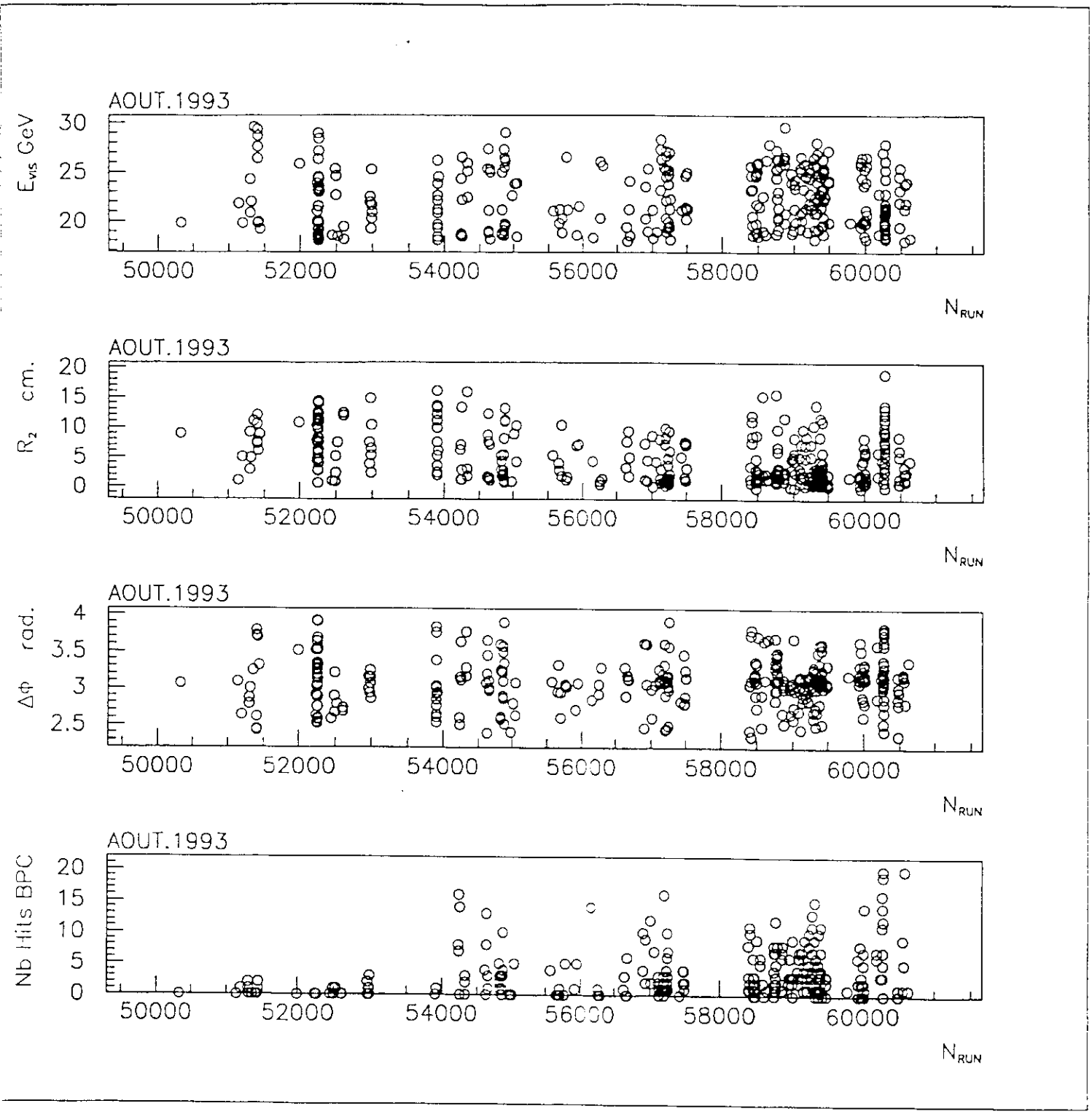
AOUT.1993
E_{vis} GeV
30
25
20
50000
52000
54000
56000
58000
60000
N_{RUN}
AOUT.1993
R_2 cm.
20
15
10
5
0
50000
52000
54000
56000
58000
60000
N_{RUN}
AOUT.1993
Δφ rad.
4
3.5
3
2.5
50000
52000
54000
56000
58000
60000
N_{RUN}
AOUT.1993
Nb Hits BPC
20
15
10
5
0
50000
52000
54000
56000
58000
60000
N_{RUN}

fig 1

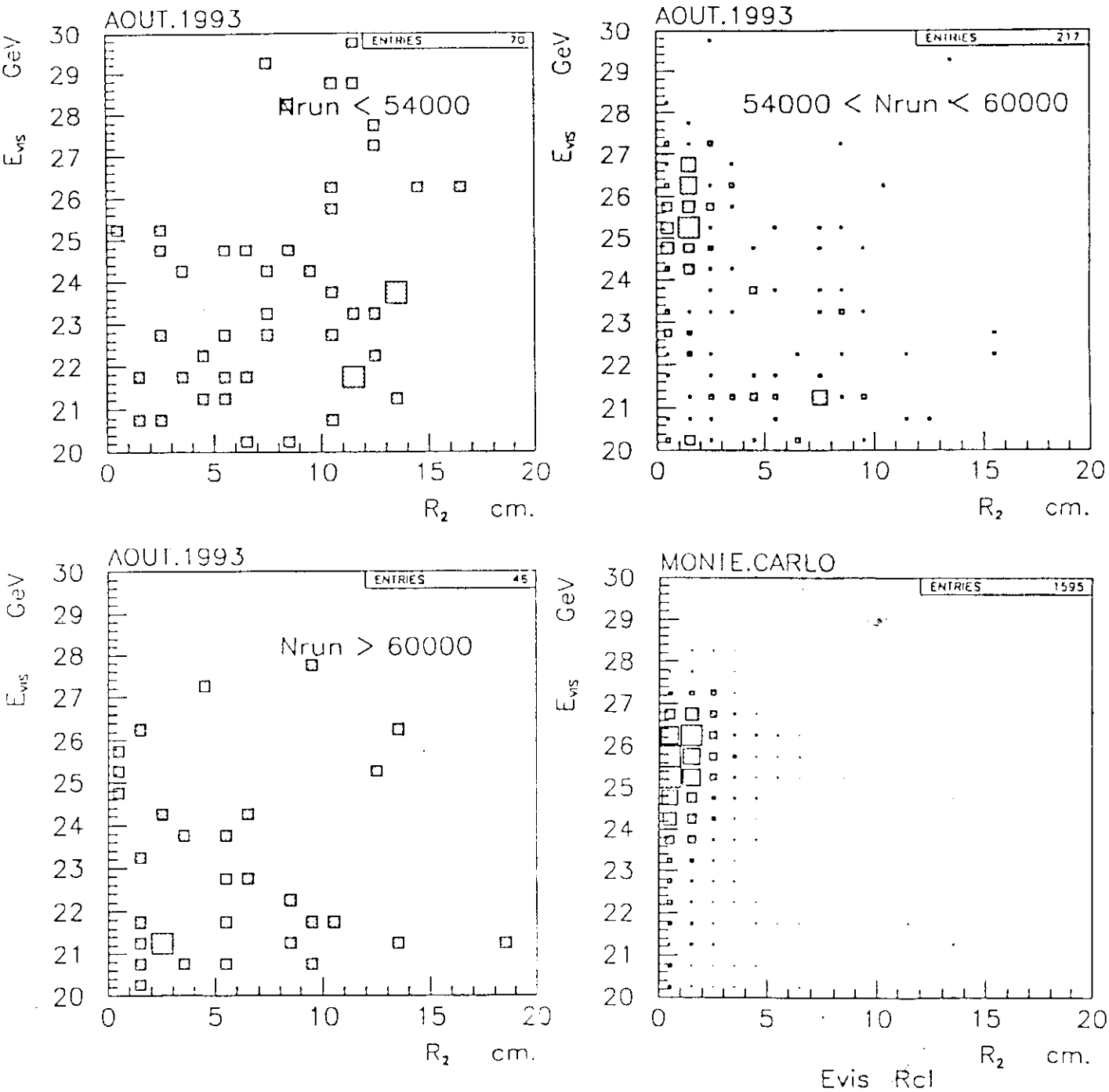
AOUT.1993
ENTRIES 70
Nrun < 54000
AOUT.1993
ENTRIES 217
54000 < Nrun < 60000
AOUT.1993
ENTRIES 45
Nrun > 60000
MONTE.CARLO
ENTRIES 1595
Evis Rcl
E_{vis} GeV
R_2 cm.

fig 2

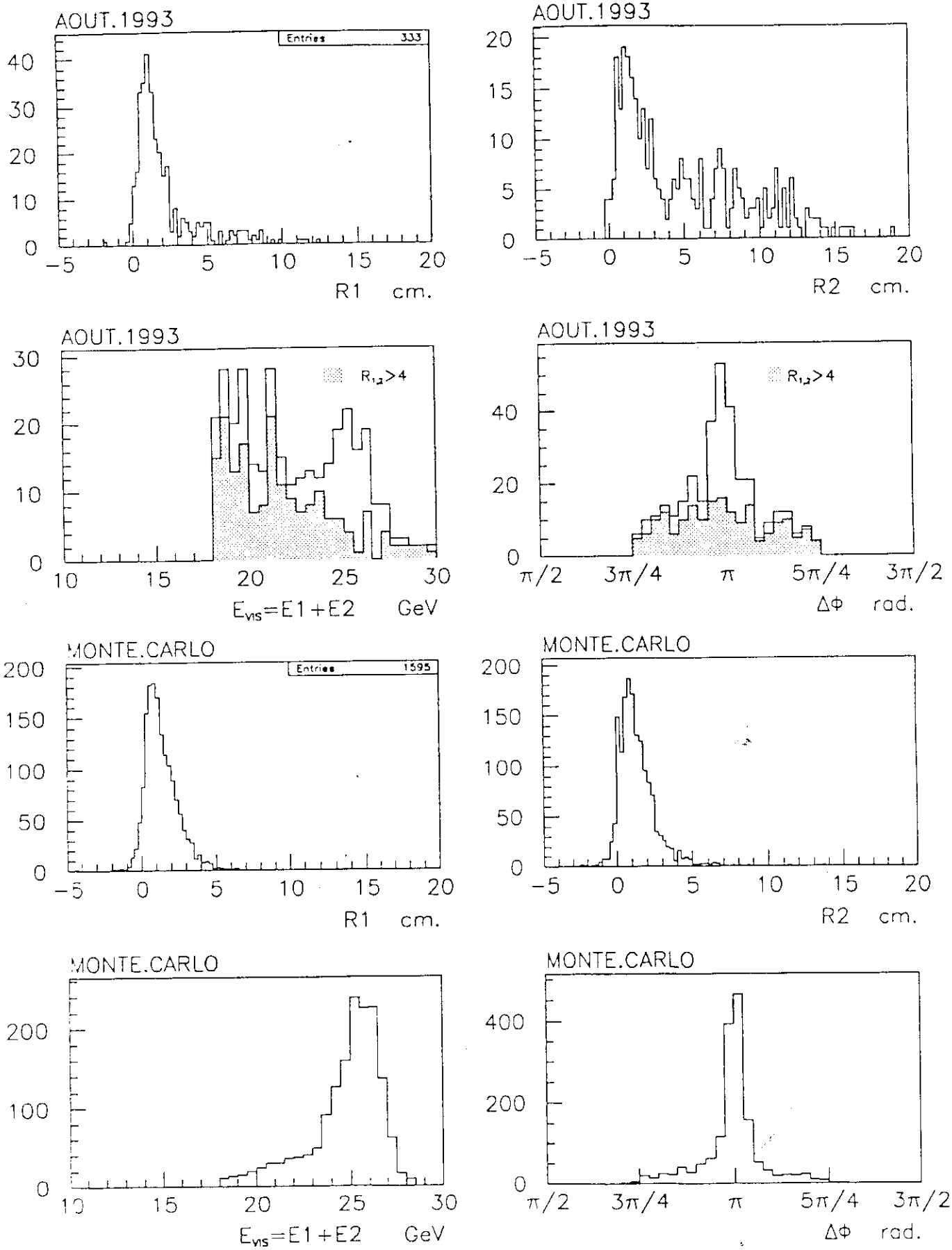
AOUT.1993
Entries 333
R1 cm.
AOUT.1993
R2 cm.
AOUT.1993
$R_{1,2}>4$
$E_{vis}=E1+E2$ GeV
AOUT.1993
$R_{1,2}>4$
$\Delta\Phi$ rad.
MONTE.CARLO
Entries 1595
R1 cm.
MONTE.CARLO
R2 cm.
MONTE.CARLO
$E_{vis}=E1+E2$ GeV
MONTE.CARLO
$\pi/2$ $3\pi/4$ π $5\pi/4$ $3\pi/2$
$\Delta\Phi$ rad.

fig 3

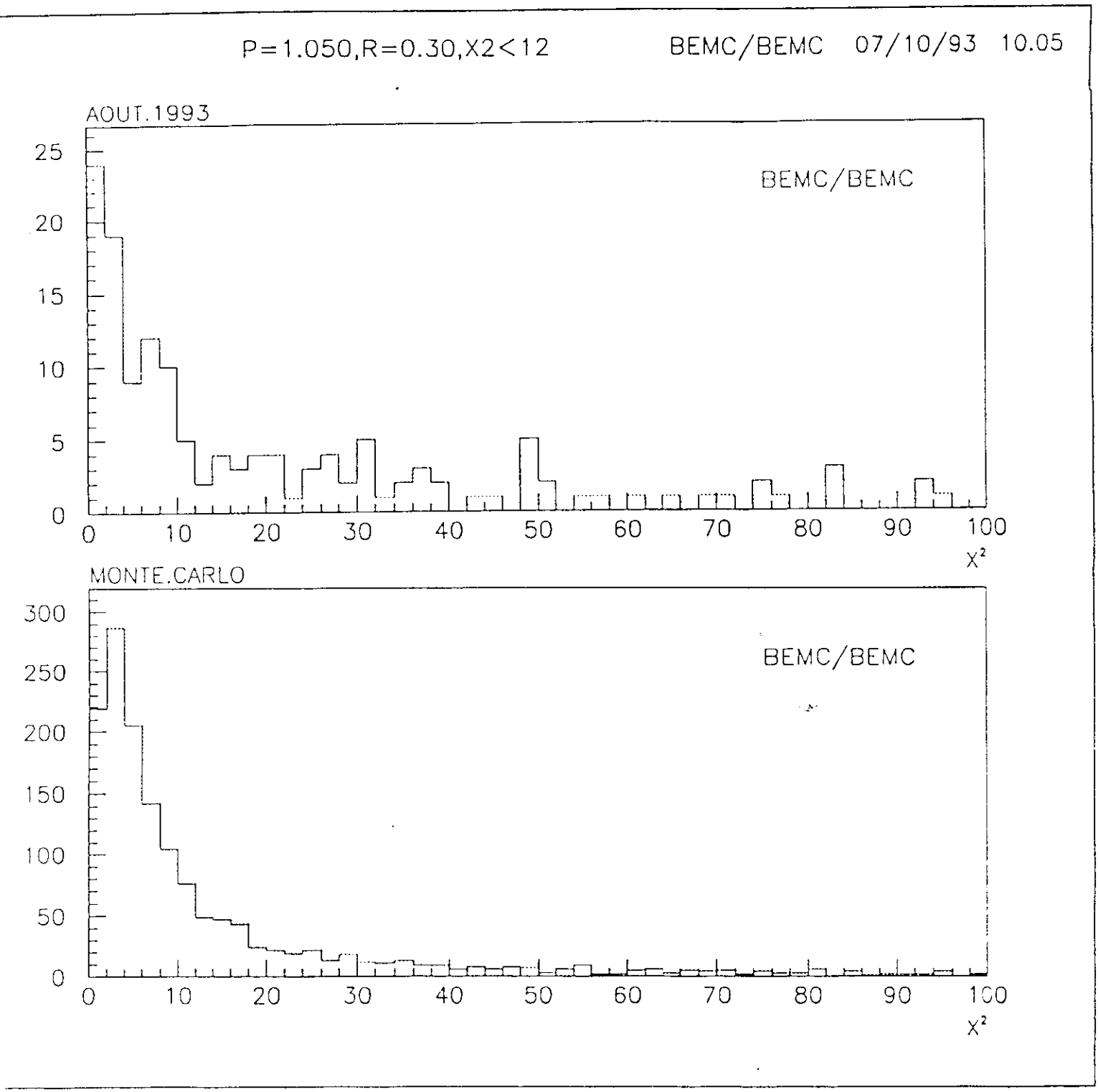
P=1.050,R=0.30,X2<12
BEMC/BEMC 07/10/93 10.05
AOUT.1993
BEMC/BEMC
25
20
15
10
5
0
0 10 20 30 40 50 60 70 80 90 100
X²
MONTE.CARLO
BEMC/BEMC
300
250
200
150
100
50
0
0 10 20 30 40 50 60 70 80 90 100
X²

fig 4

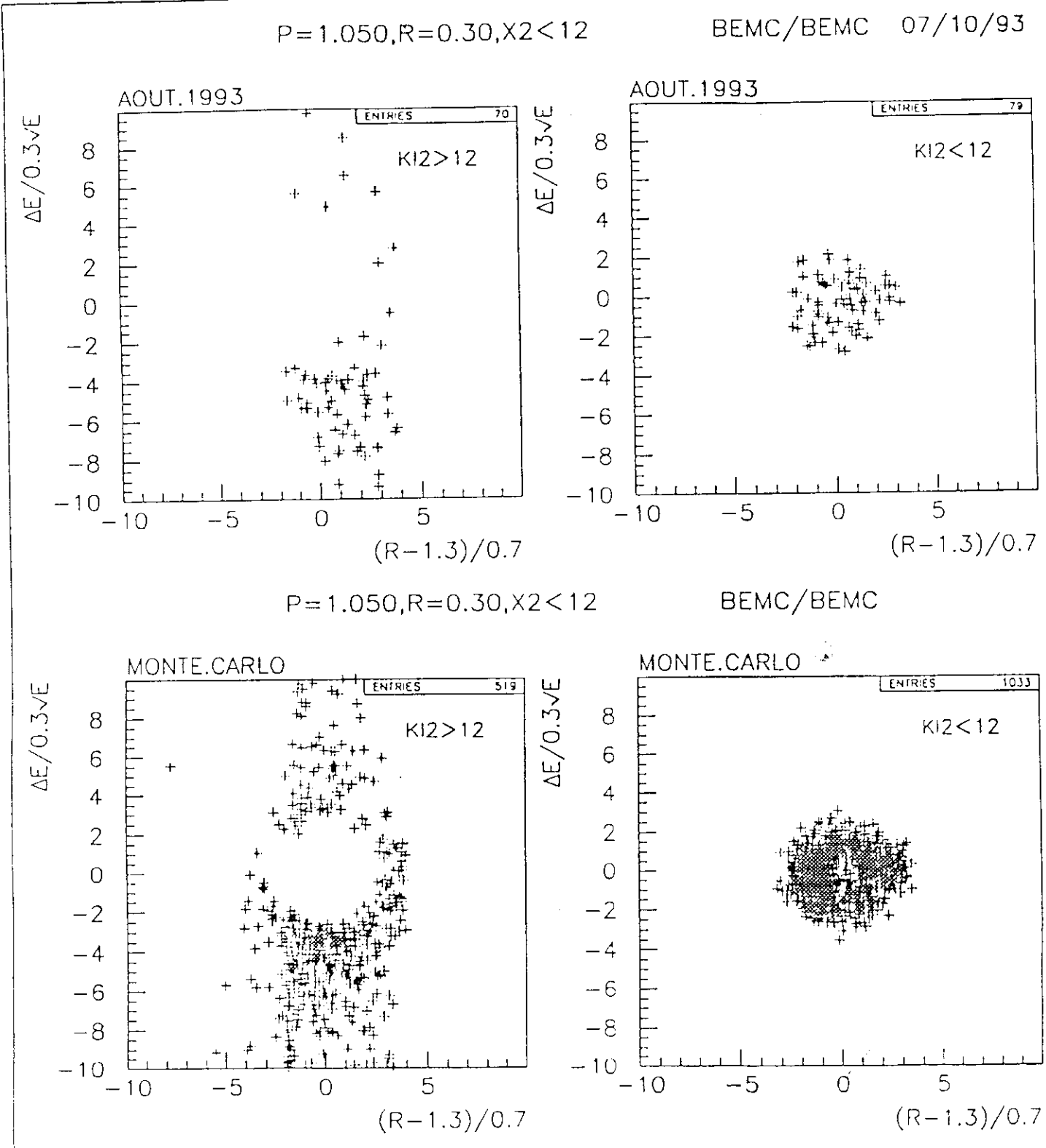
P=1.050,R=0.30,X2<12
BEMC/BEMC 07/10/93 10.03
AOUT.1993
ENTRIES 70
KI2>12
ΔE/0.3√E
(R−1.3)/0.7
AOUT.1993
ENTRIES 79
KI2<12
ΔE/0.3√E
(R−1.3)/0.7
P=1.050,R=0.30,X2<12
BEMC/BEMC
MONTE.CARLO
ENTRIES 519
KI2>12
ΔE/0.3√E
(R−1.3)/0.7
MONTE.CARLO
ENTRIES 1033
KI2<12
ΔE/0.3√E
(R−1.3)/0.7

fig 5

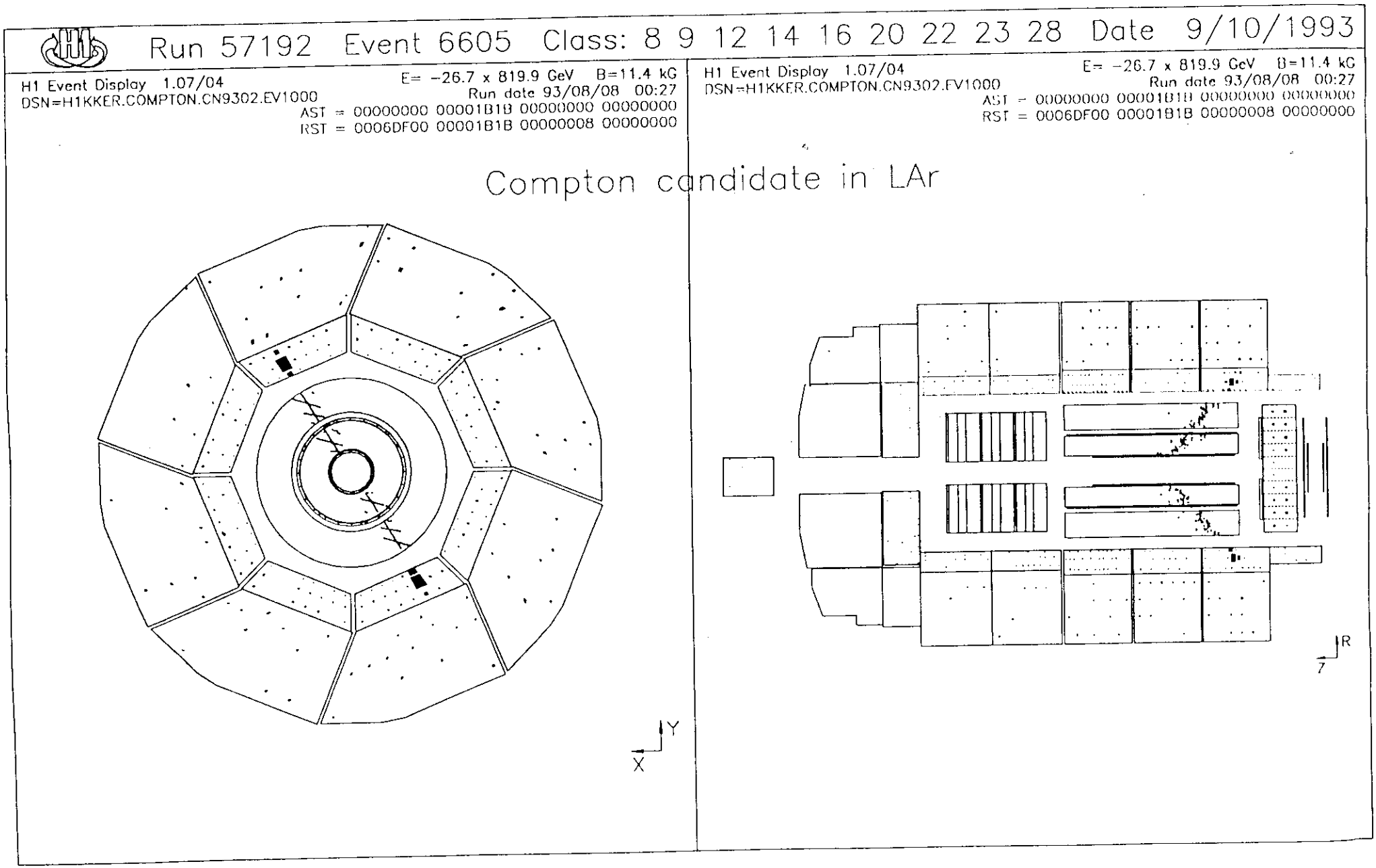
Run 57192 Event 6605 Class: 8 9 12 14 16 20 22 23 28 Date 9/10/1993
H1 Event Display 1.07/04
DSN=H1KKER.COMPTON.CN9302.EV1000
E= -26.7 x 819.9 GeV B=11.4 kG
Run date 93/08/08 00:27
AST = 00000000 00001B1B 00000000 00000000
RST = 0006DF00 00001B1B 00000008 00000000
Compton candidate in LAr
Y
X
R
Z

fig 6

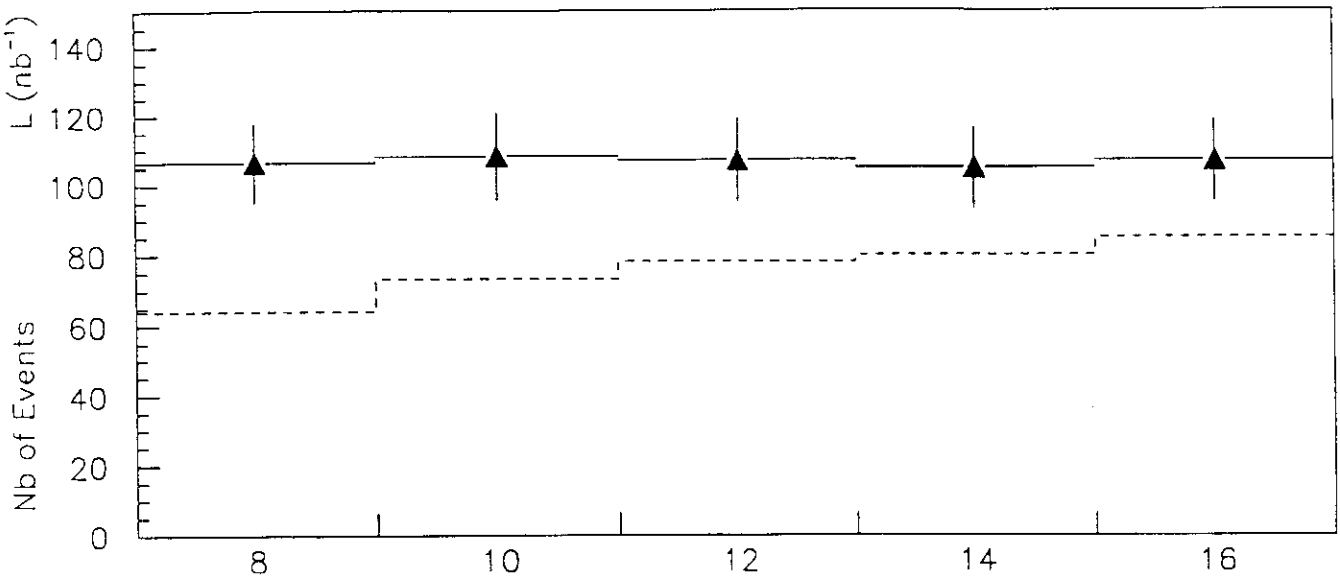
L (nb⁻¹)
140
120
100
80
60
40
20
0
Nb of Events
8
10
12
14
16
CUT ON X²

fig 7

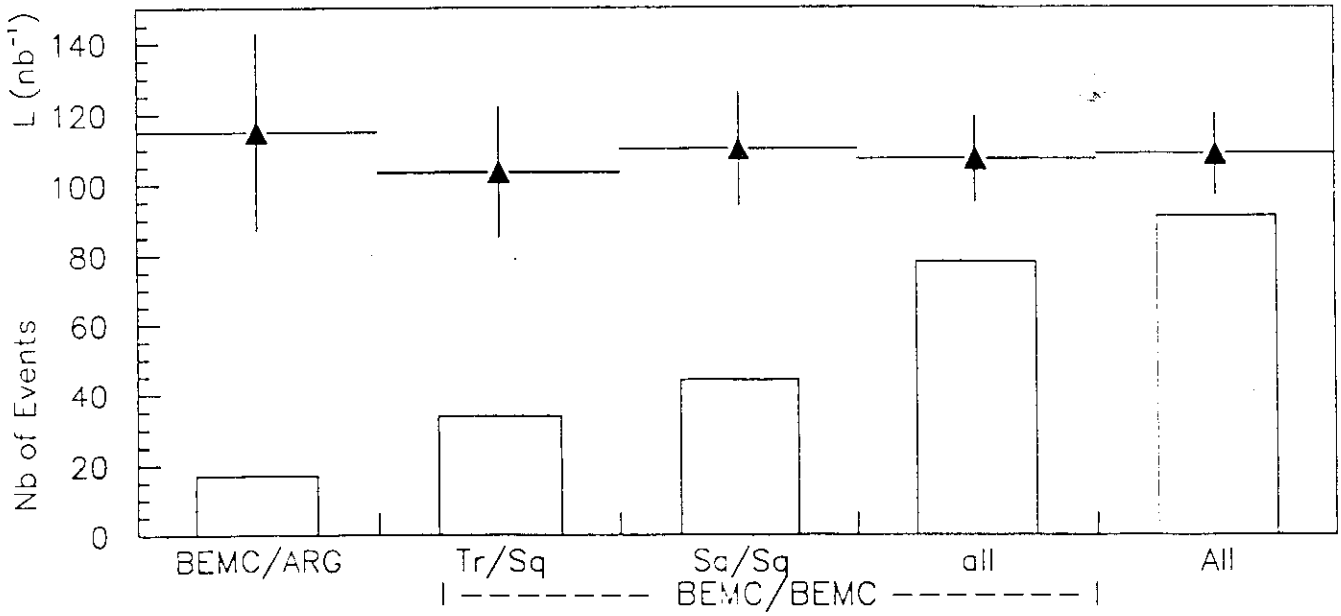
L (nb⁻¹)
140
120
100
80
60
40
20
0
Nb of Events
BEMC/ARG
Tr/Sq
Sq/Sq
all
All
BEMC/BEMC

fig 8

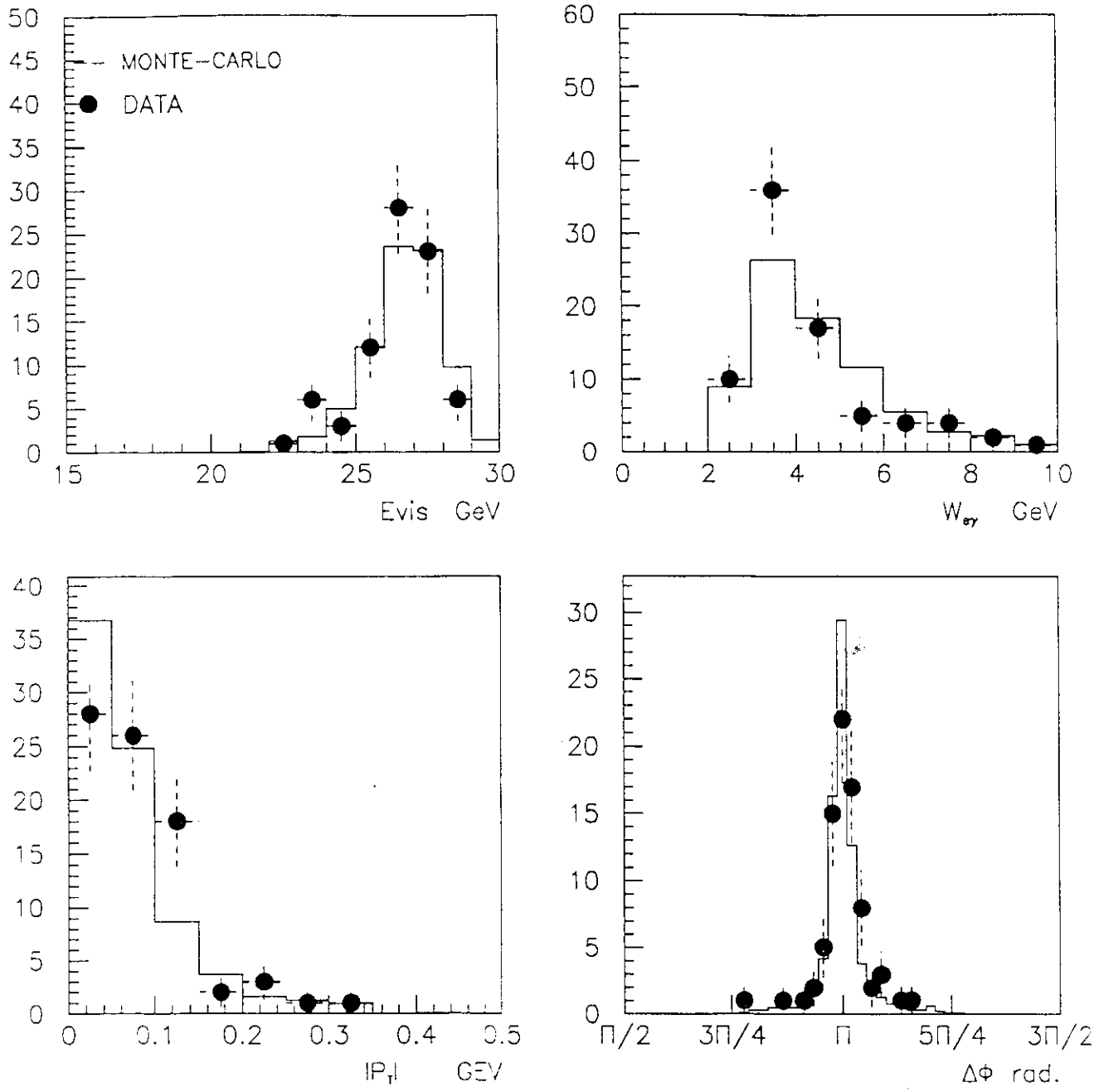
MONTE-CARLO
DATA
Evis GeV
$W_{\sigma\gamma}$ GeV
$|P_T|$ GEV
Δφ rad.
Π/2
3Π/4
Π
5Π/4
3Π/2

fig 9

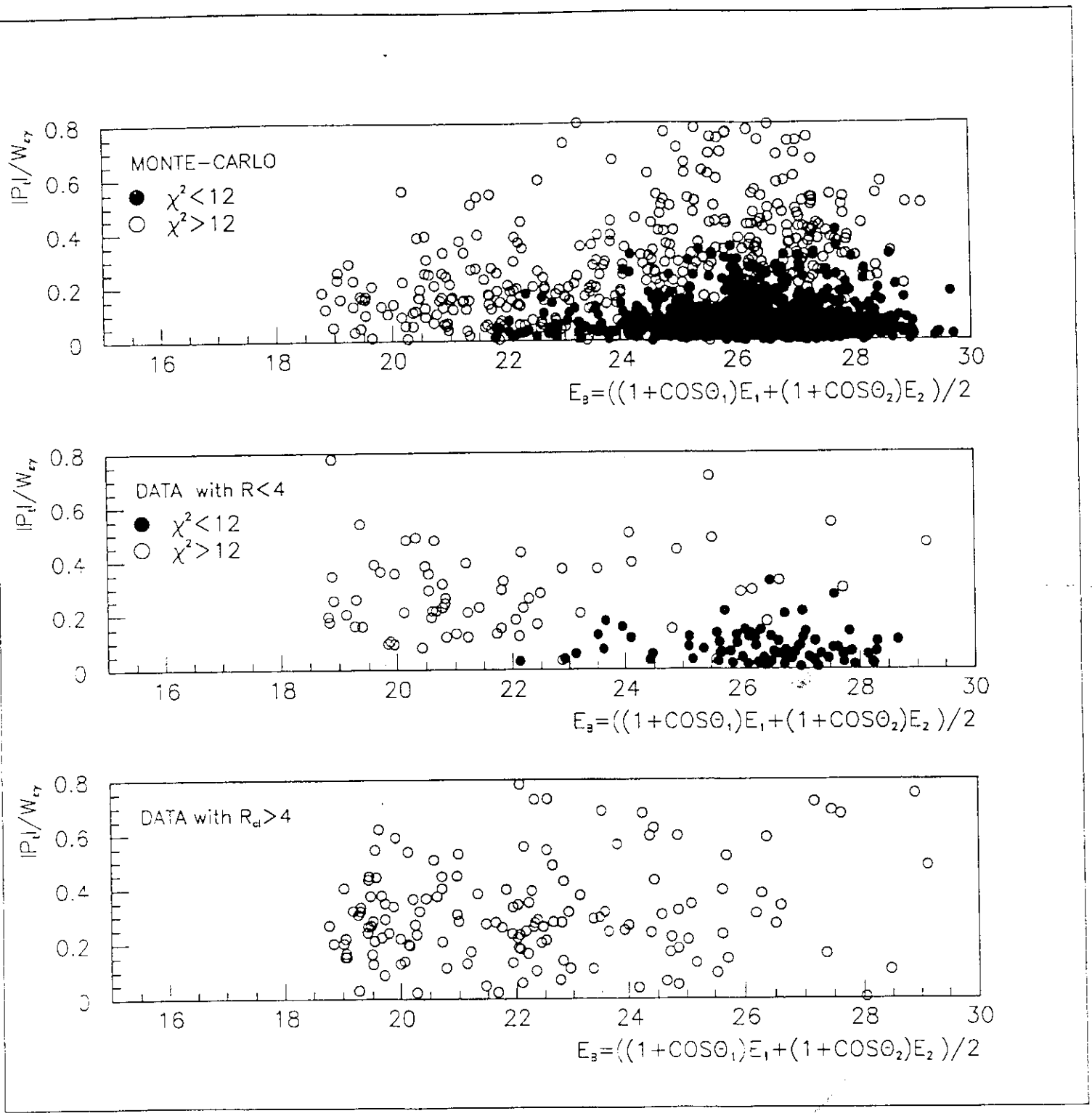
MONTE−CARLO
$\chi^2<12$
$\chi^2>12$
$|P_t|/W_{ev}$
$E_B=((1+COS\Theta_1)E_1+(1+COS\Theta_2)E_2)/2$
DATA with R<4
$\chi^2<12$
$\chi^2>12$
$|P_t|/W_{ev}$
$E_B=((1+COS\Theta_1)E_1+(1+COS\Theta_2)E_2)/2$
DATA with $R_{cl}>4$
$|P_t|/W_{ev}$
$E_B=((1+COS\Theta_1)E_1+(1+COS\Theta_2)E_2)/2$

fig 10