DELPHI @ 130-140 GeV

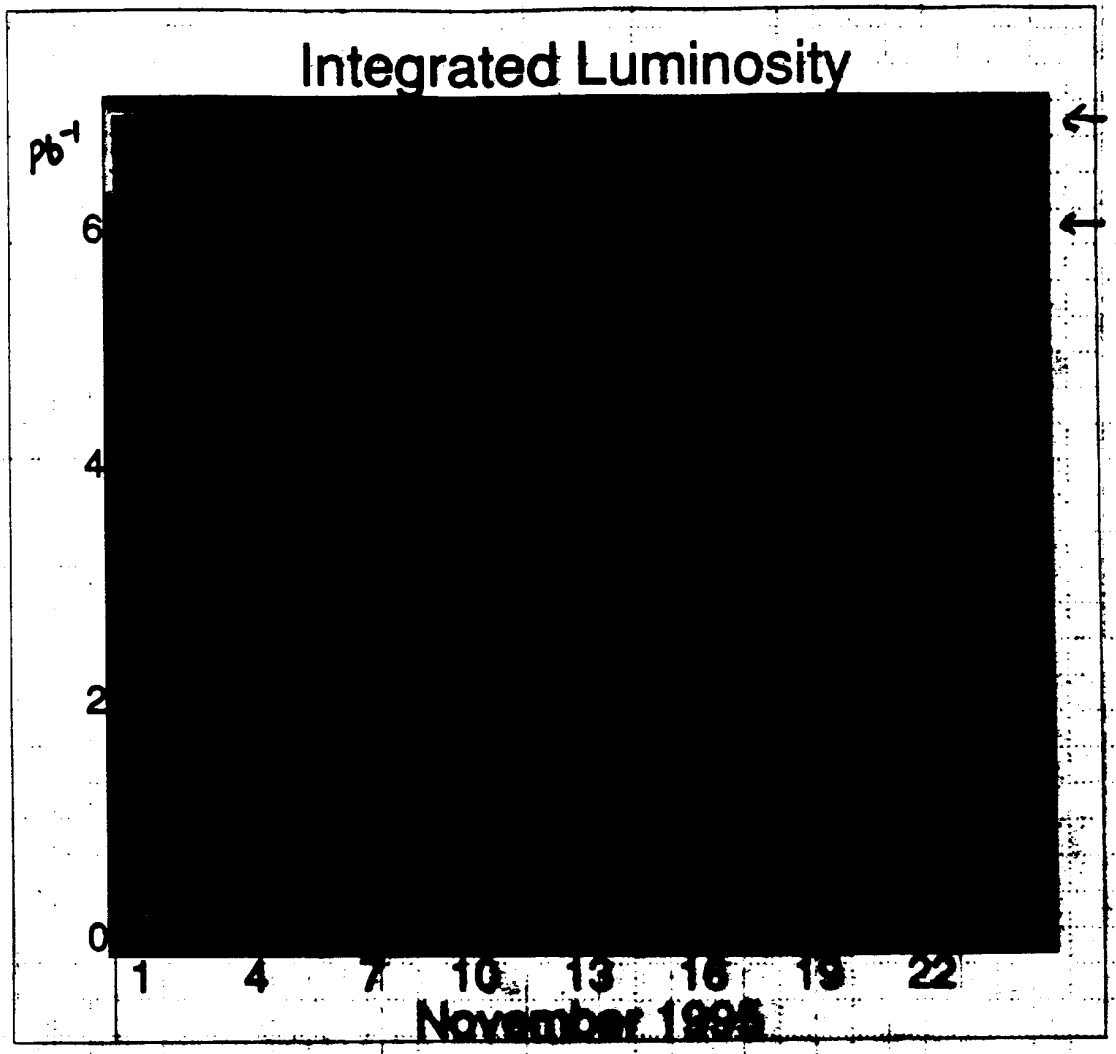
- $\mathcal{L}$ + background

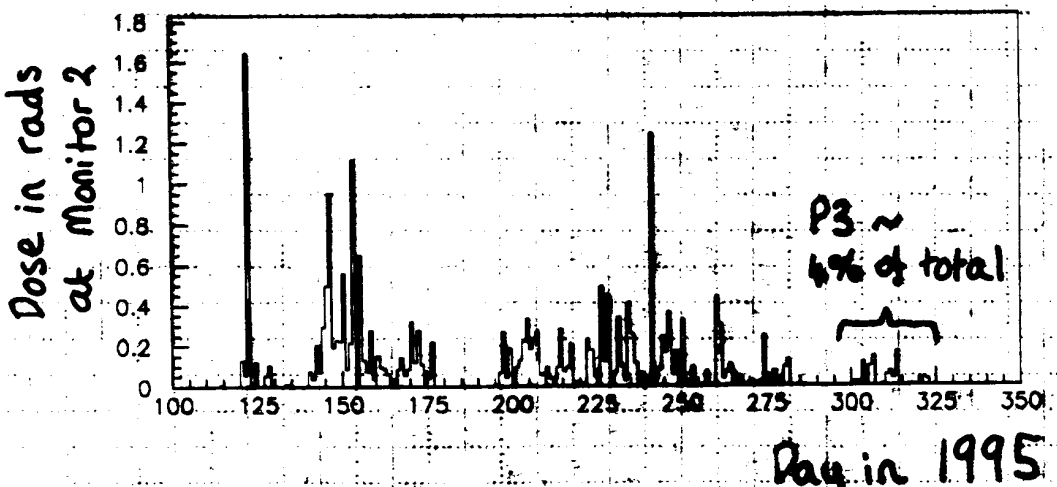
- Discoveries
  - $\mu\mu, \tau\tau, ee + n\gamma$
  - $q\bar{q}(\gamma)$
  - $\gamma\gamma$ collisions

- Searches
  - $\tilde{\chi}^{\pm}$
  - $\tilde{\chi}^{0}$
  - $\tilde{\ell}$
  - hA

- Conclusion

CERN LIBRARIES, GENEVA
CERN-PRE-95-004


Integrated Luminosity
pb⁻¹
6
4
2
0
1
4
7
10
13
16
19
22
November 1995
7.2
5.9


Dose in rads at Monitor 2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
100
125
150
175
200
225
250
275
300
325
350
P3 ~ 6% of total
Day in 1995

PRELIMINARY

$e^+e^- \rightarrow \mu^+\mu^-\gamma$

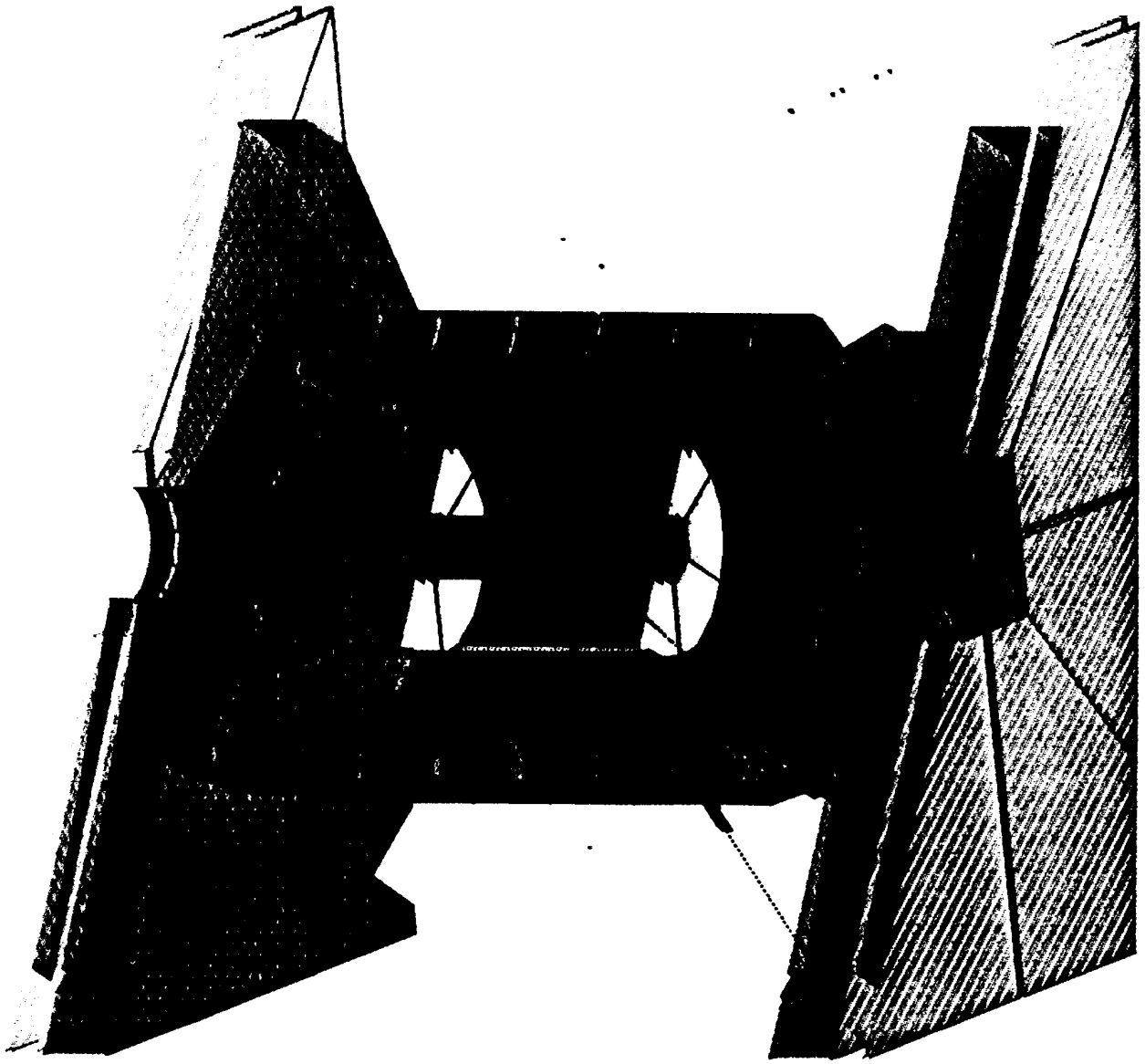
$M_{\mu^+\mu^-} = 90$ GeV.

DELPHI Interactive Analysis

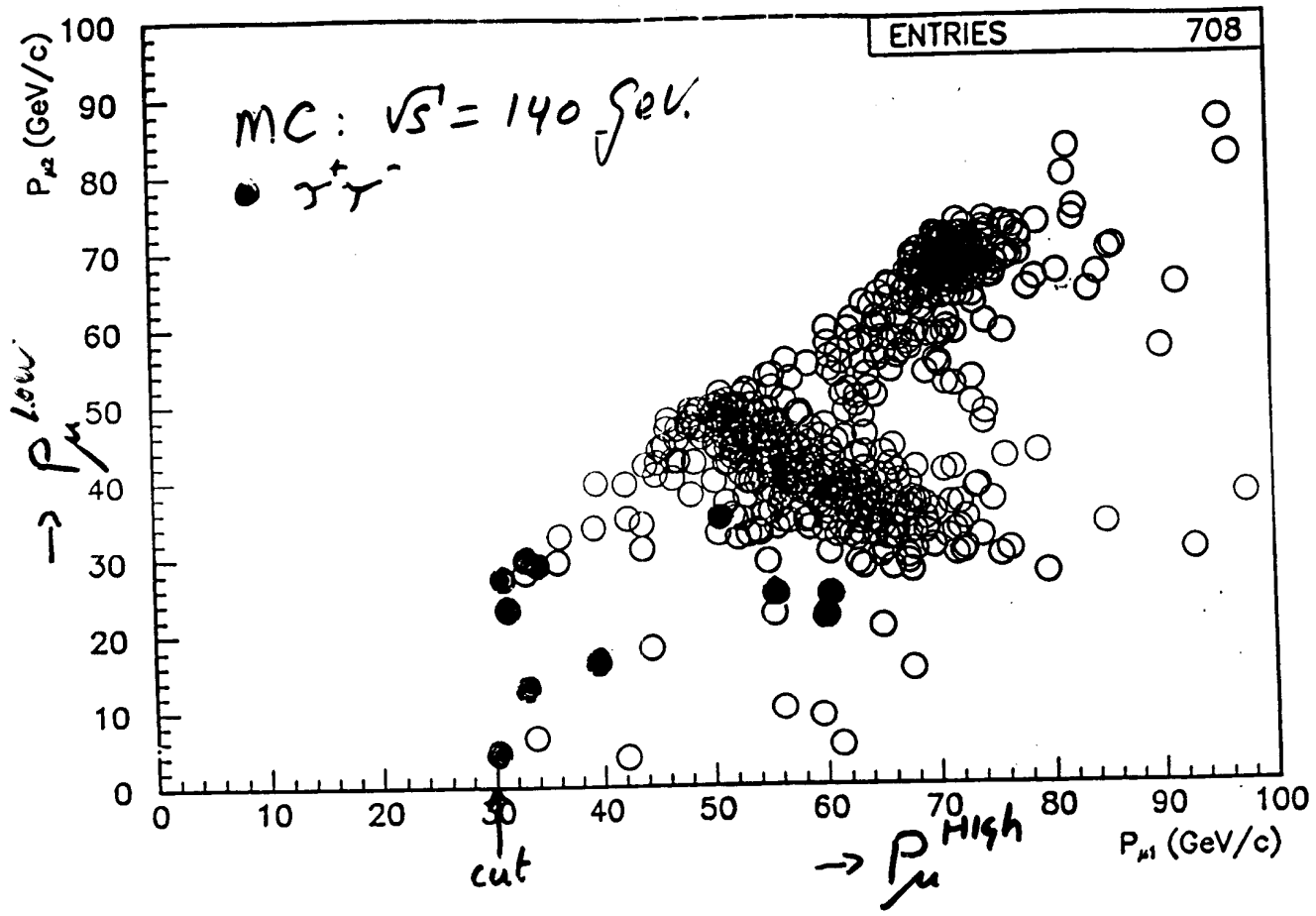
Beam: 65.2 GeV Run: 64092 DAS: 6-Nov-1995 17:00:45

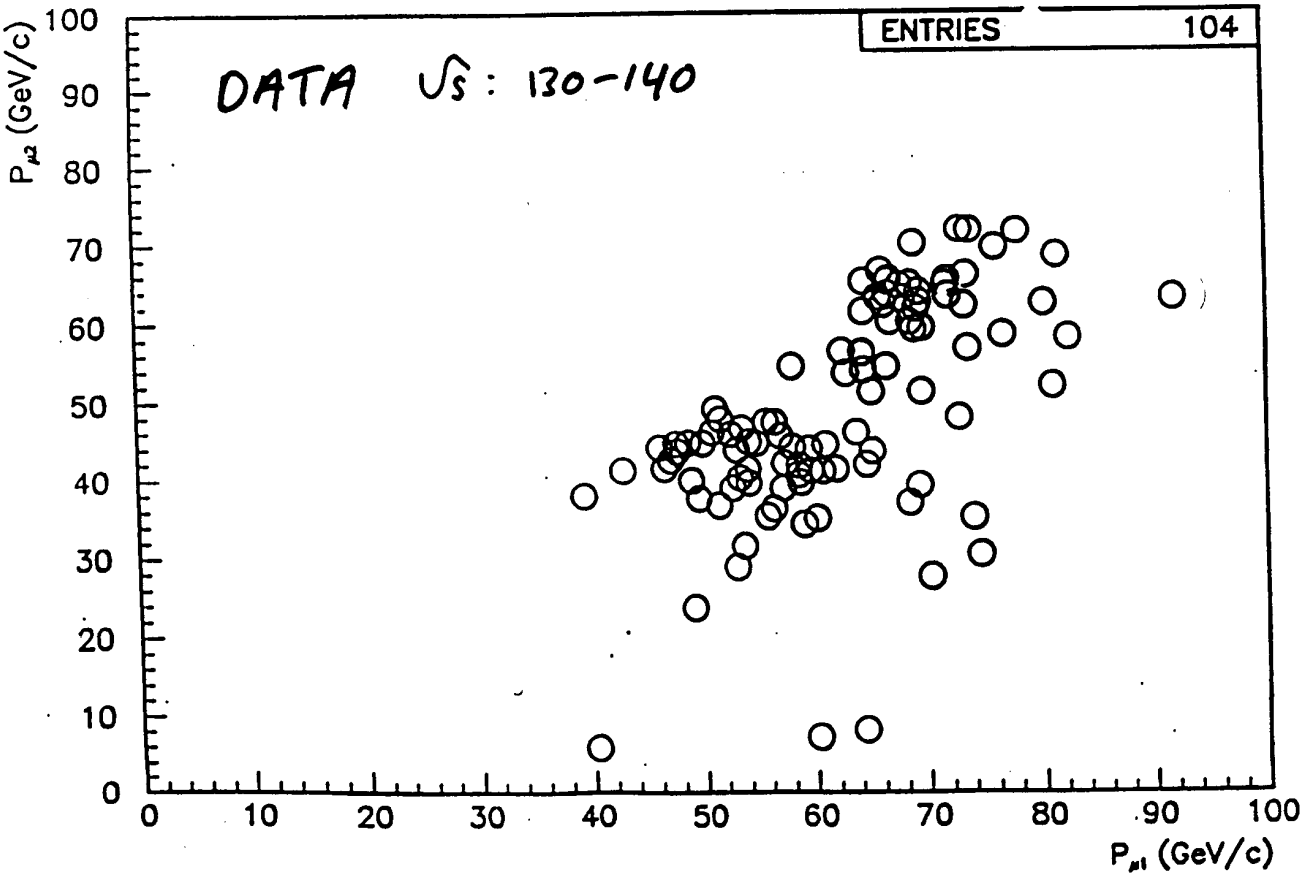
Proc: 1-Dec-1995 Evt: 23763 Scan: 4-Dec-1995

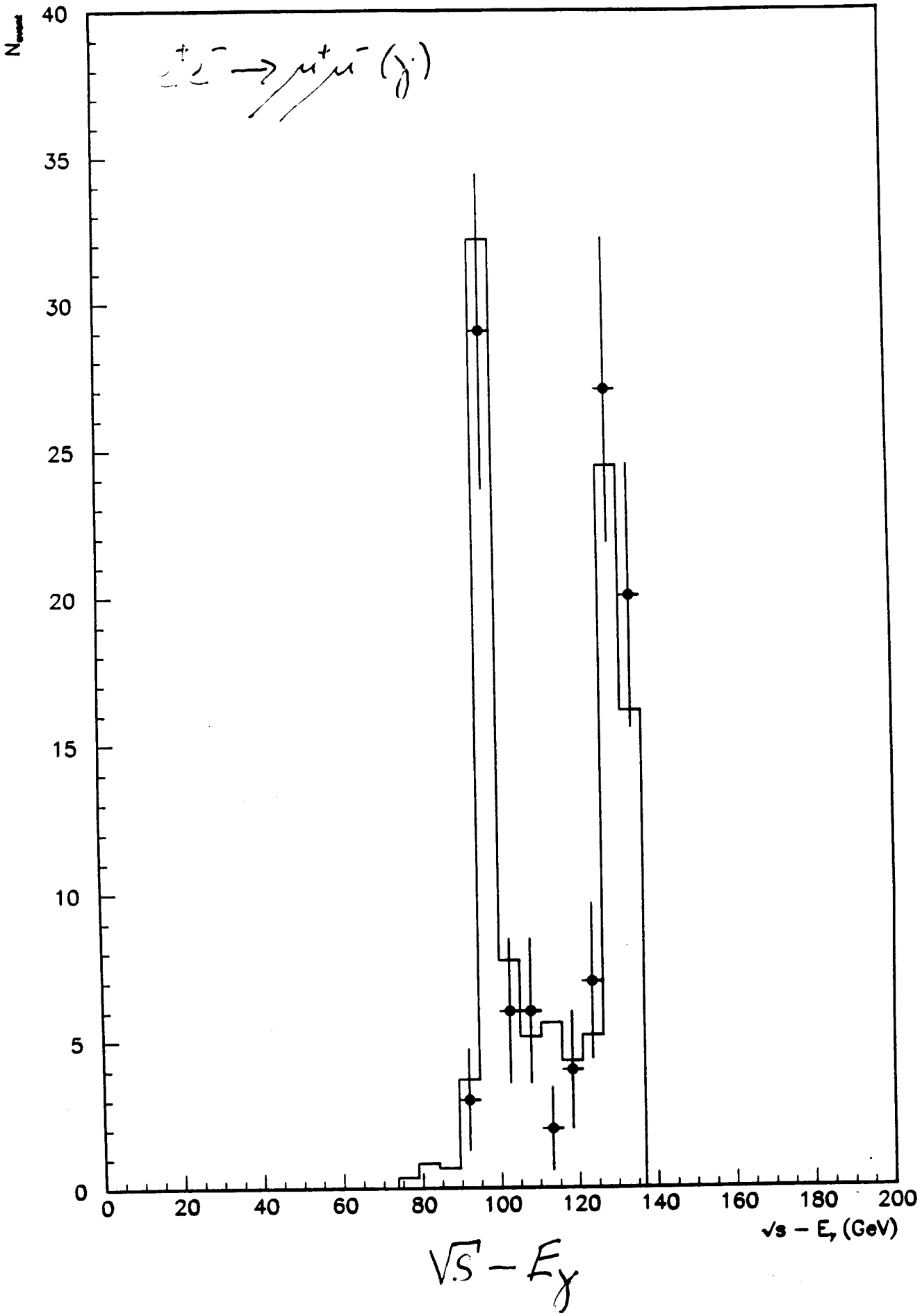
	TD	TE	TS	TK	TV	ST	PA
Act	1	72	0	3	0	0	0
	(68)	(80)	(0)	(3)	(0)	(0)	(0)
Deact	0	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)	(0)

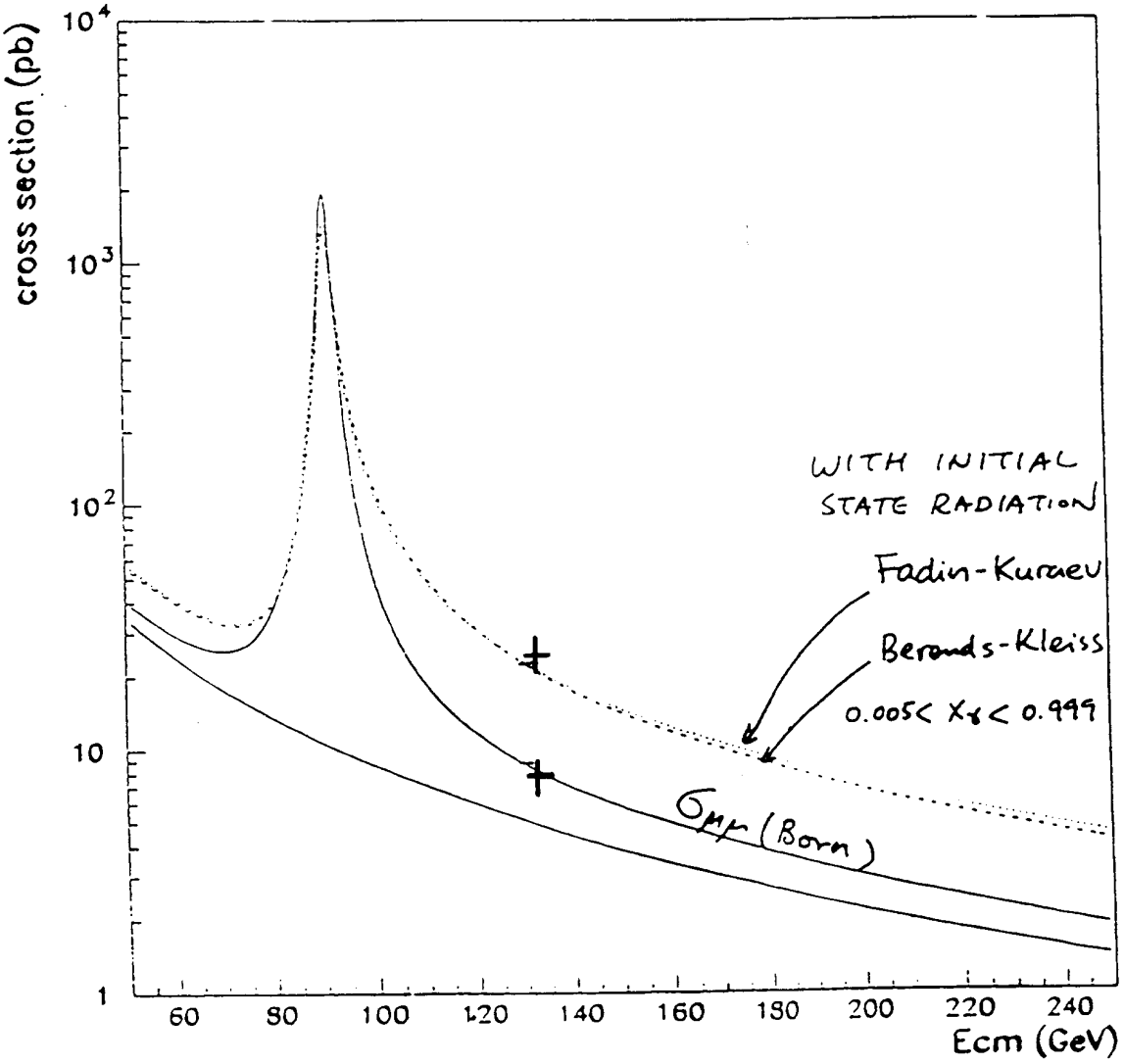


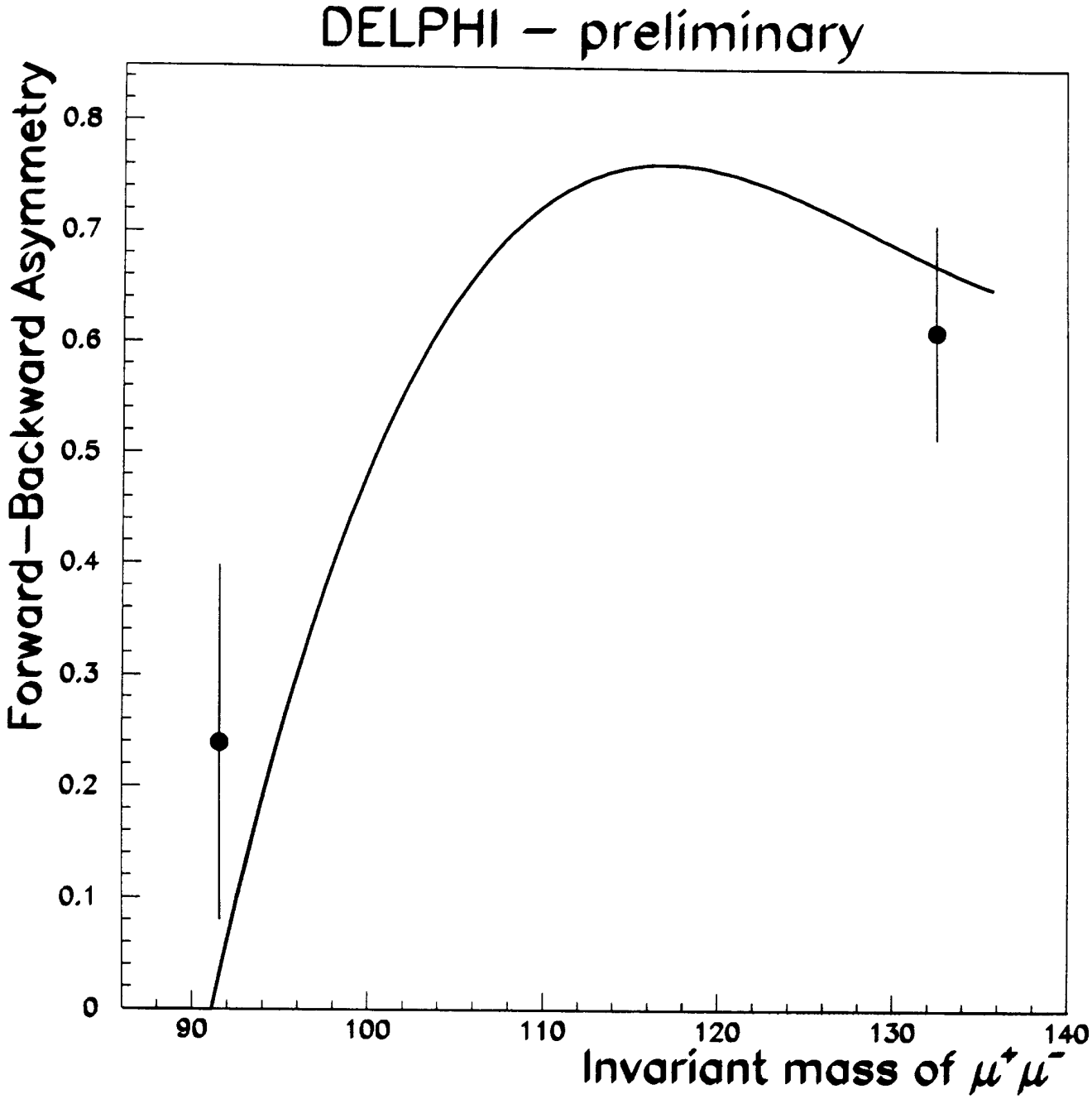
$e^+e^- \to \mu^+\mu^-(\gamma)$



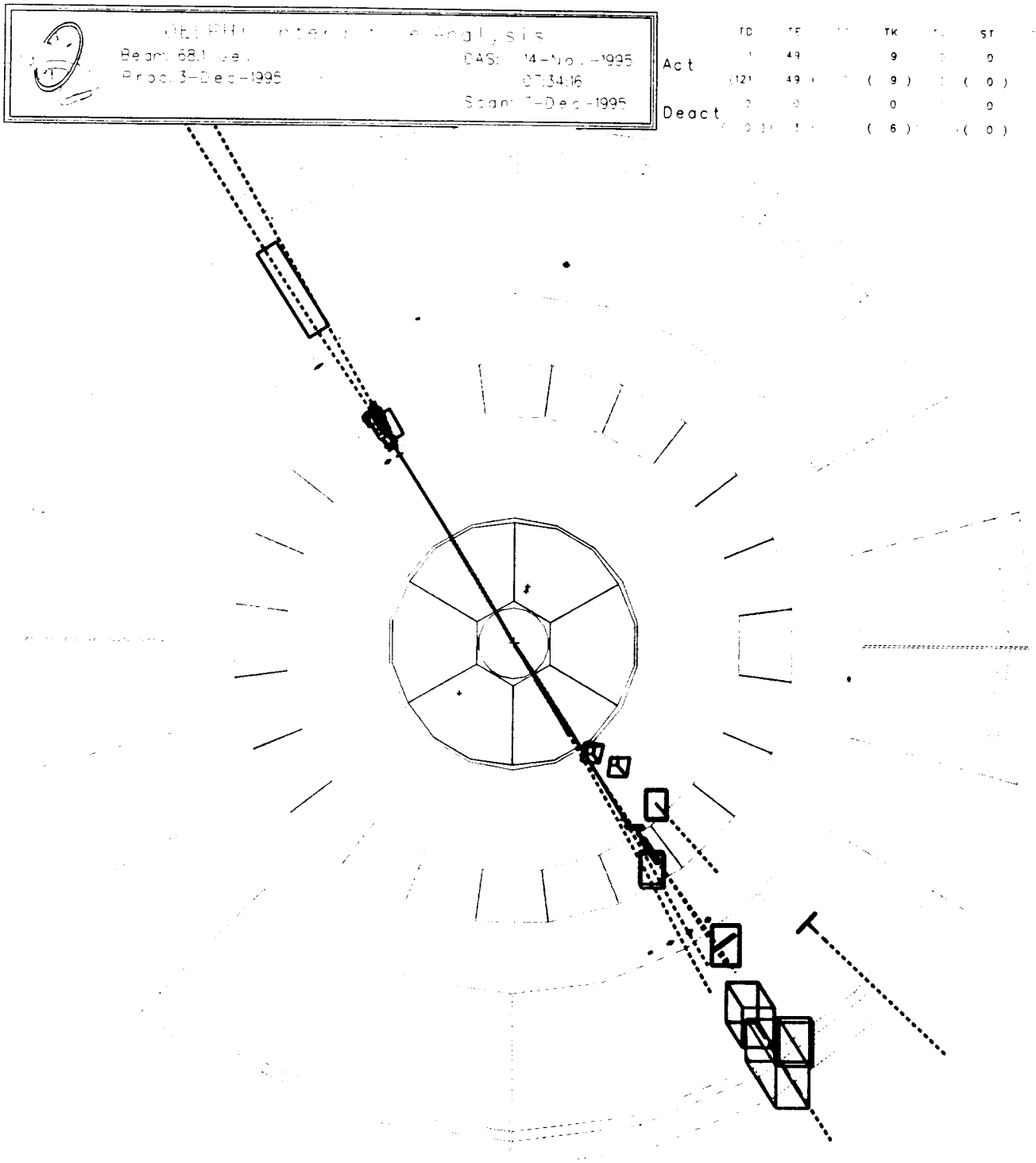



$e^+e^- \to \mu^+\mu^-(\gamma)$
N_{events}
40
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
200
$\sqrt{s} - E_\gamma$ (GeV)
$\sqrt{s} - E_\gamma$


cross section (pb)
10^4
10^3
10^2
10
1
60
80
100
120
140
160
180
200
220
240
Ecm (GeV)
WITH INITIAL STATE RADIATION
Fadin-Kuraev
Berends-Kleiss
$0.005 < x_\gamma < 0.999$
$\sigma_{\mu\mu}$ (Born)


DELPHI – preliminary
Forward–Backward Asymmetry
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
90
100
110
120
130
140
Invariant mass of $\mu^+\mu^-$

$e^+e^- \to \tau\tau(\gamma)$



1 VS 3 prong

$e^+e^- \to \tau\tau(\gamma)$

DELPHI Interactive Analysis

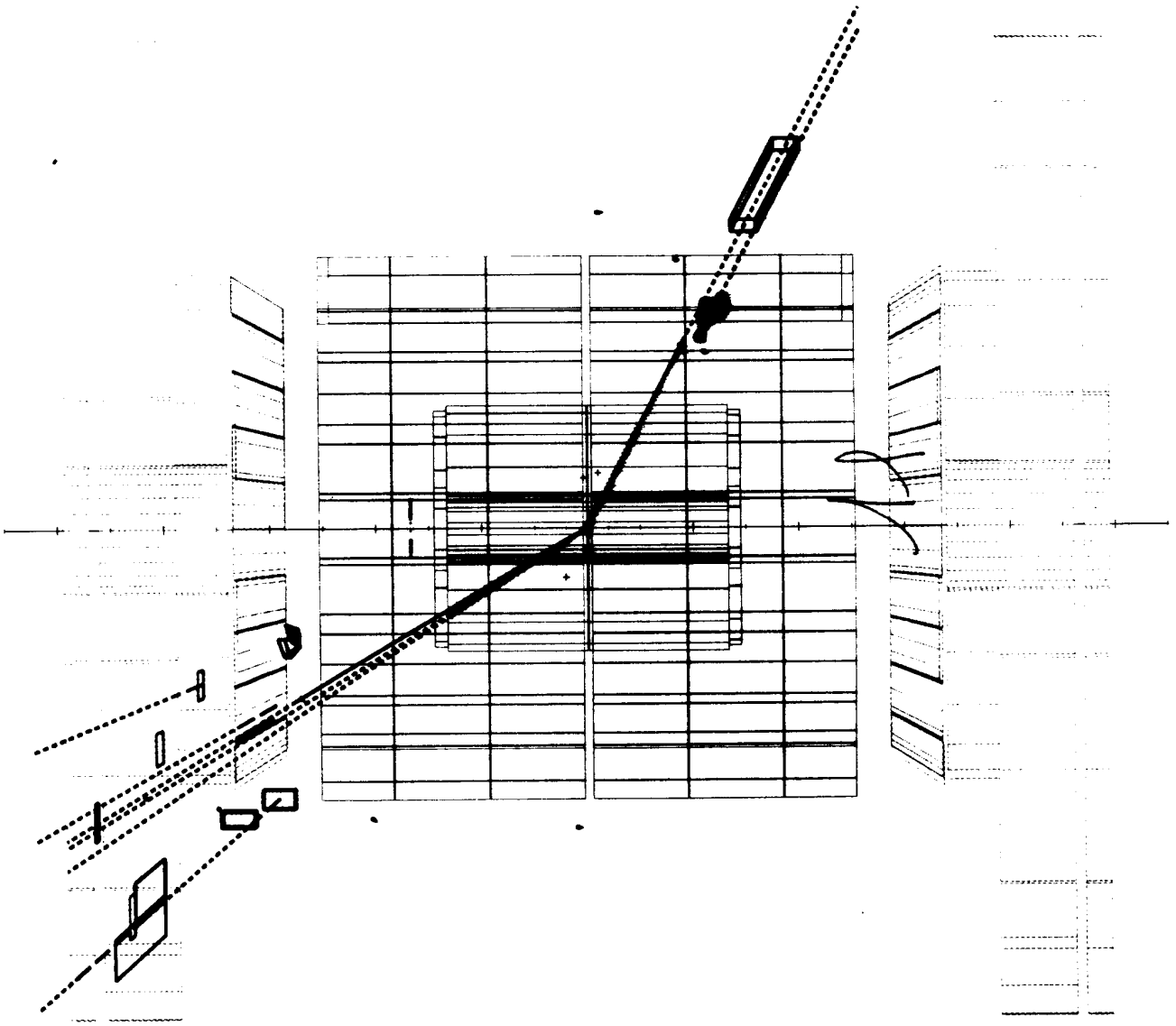
Beam: 68.1 GeV

Proc: 3-Dec-1995

DAS: 14-Nov.-1995 07:34:16

Scan: 7-Dec-1995

	TD	TE	TS	TK	T.	ST	FA
Act	8	27	0	9	0	0	0
	(121)	(49)	(0)	(9)	(0)	(0)	(
Deact	0	0	0	0	0	0	
	(0)	(3)	(0)	(6)	(0)	(0)	

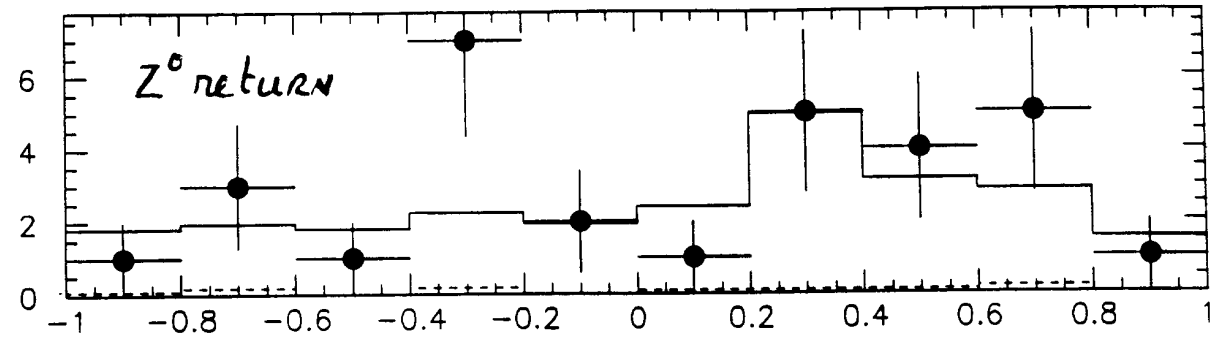


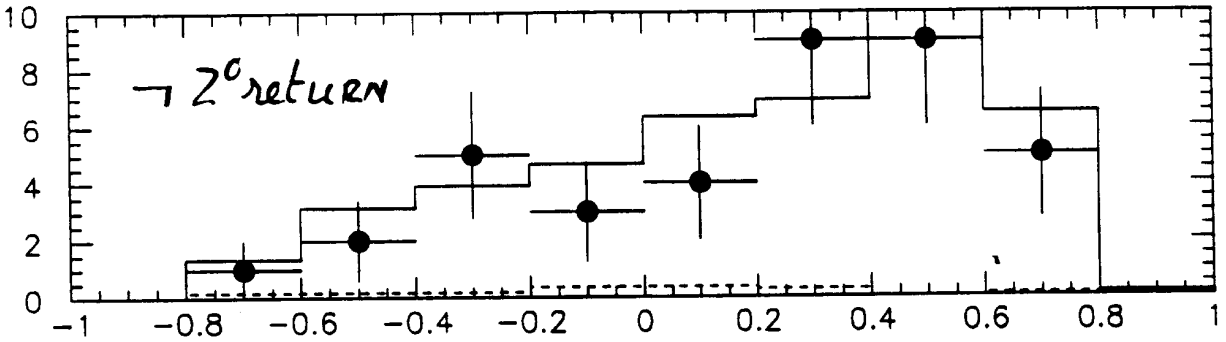
$e^+e^- \to \tau\tau$ (γ)

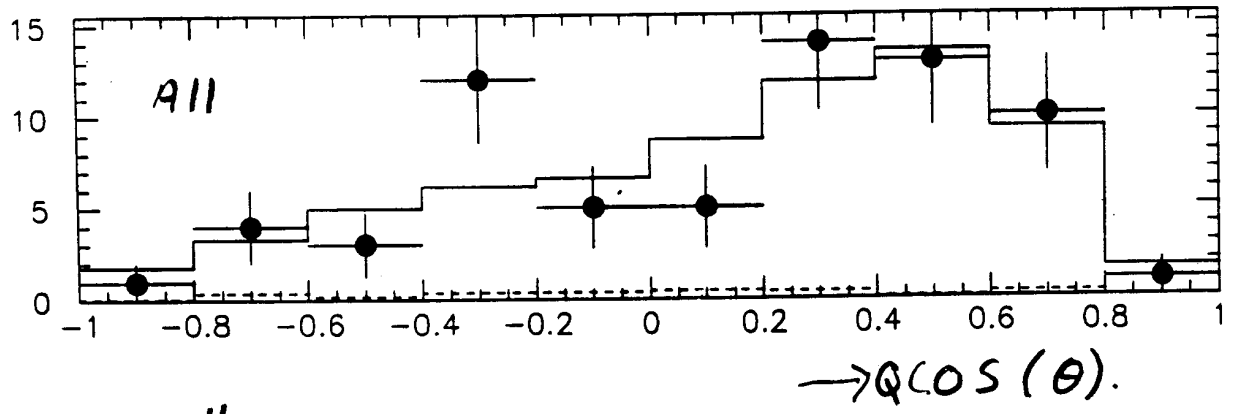
Selection: 1 vs n , Eff = 21 % (background = 6 %)

events : 34 (15 $\to Z^0$)

σ (pb) : 25.0 ± 4.4 (Expect: 21)

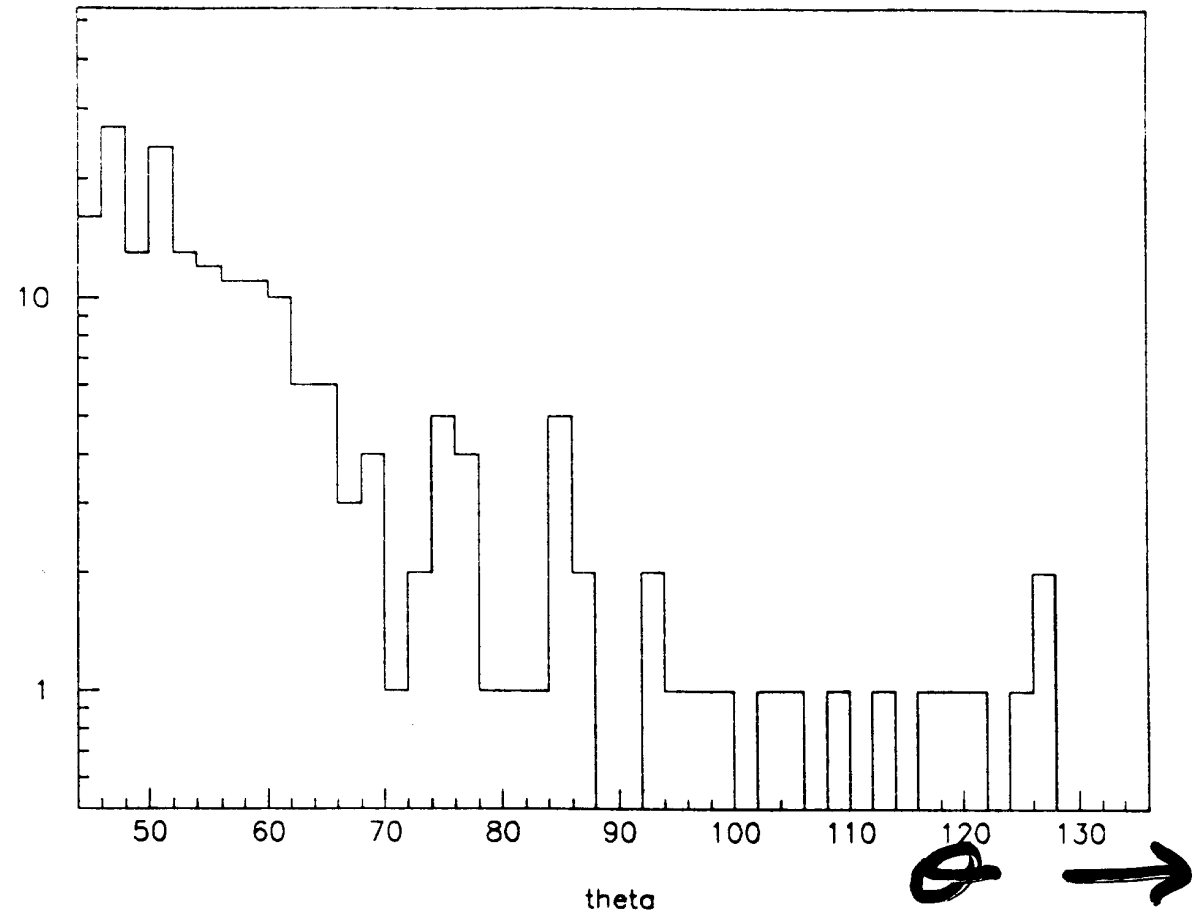


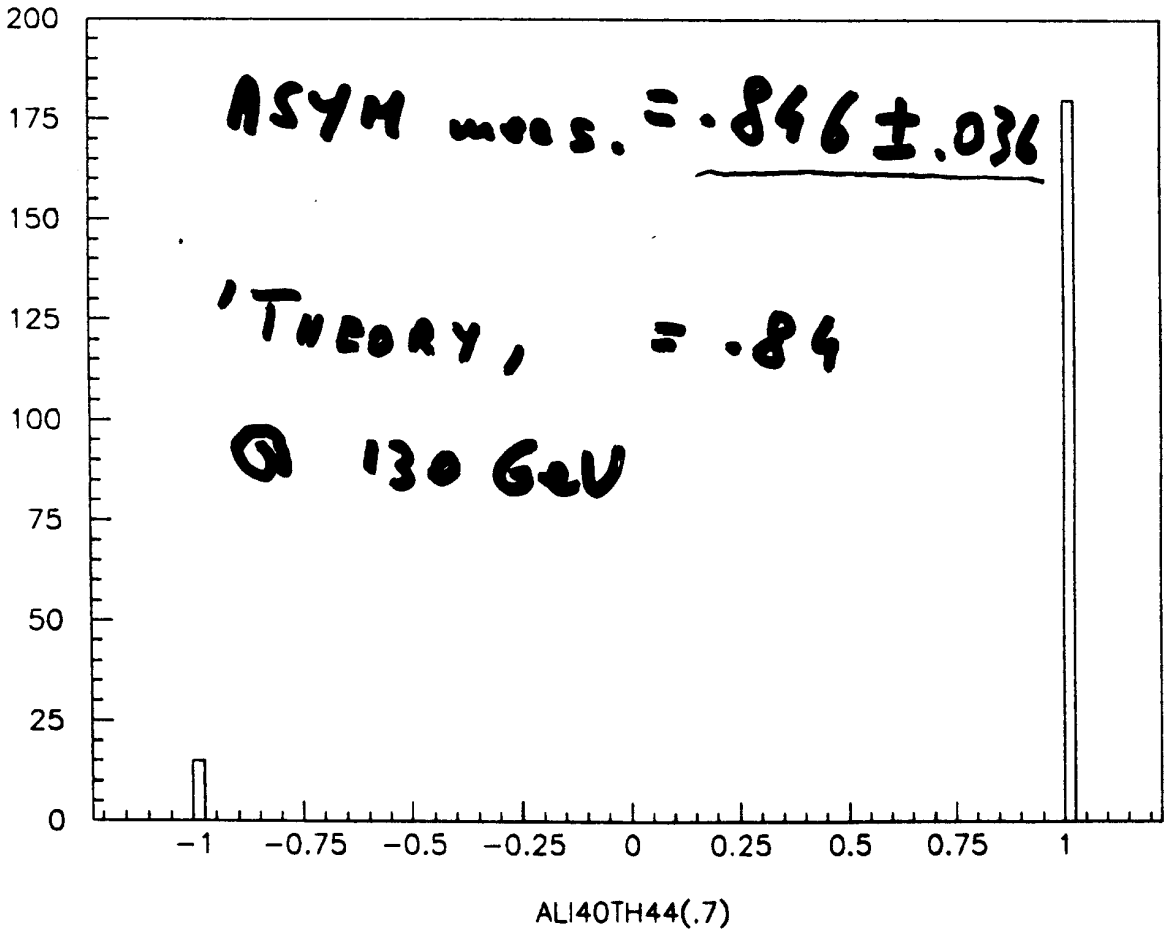




$A_{FB}^{all} = 0.29 \pm 0.16$

$ee \to ee$ $e^- \leftarrow \tau_{<10^\circ}$ 95/12/08 10.10



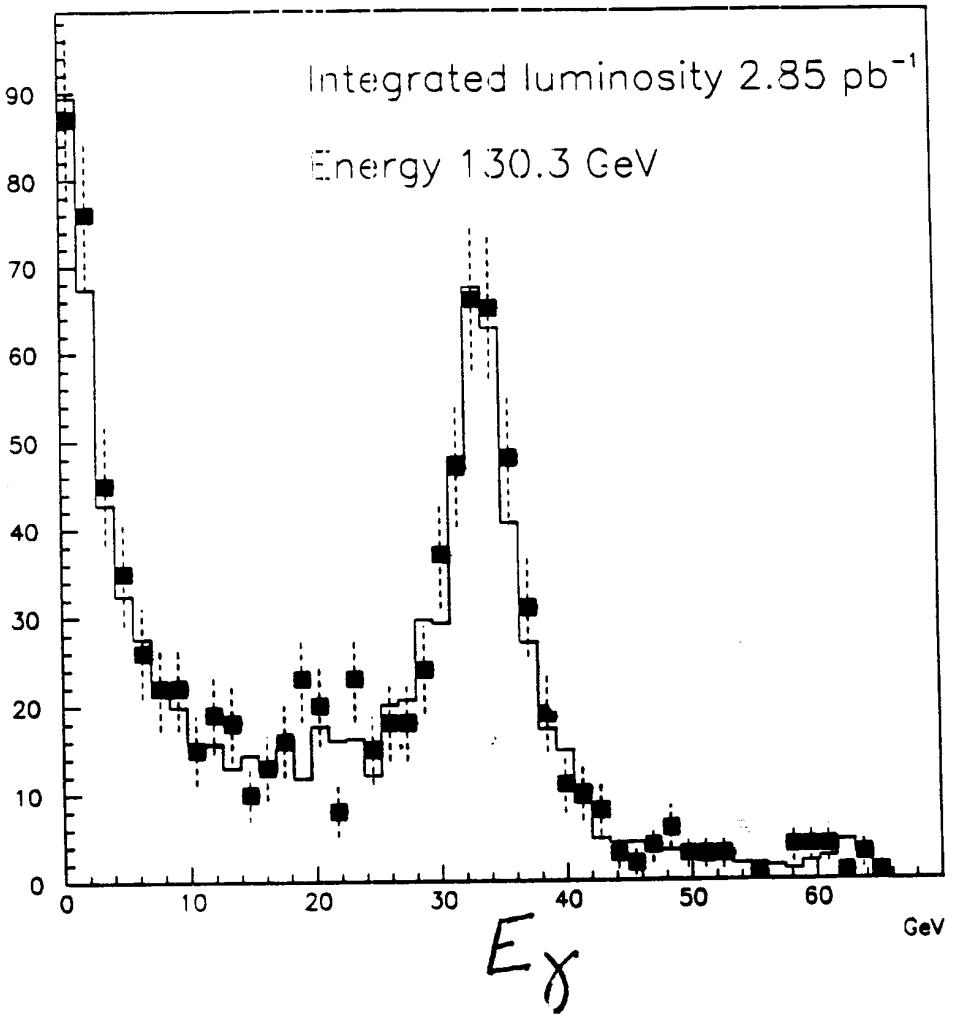


ASYM meas. = .846 ± .036

'THEORY, = .84

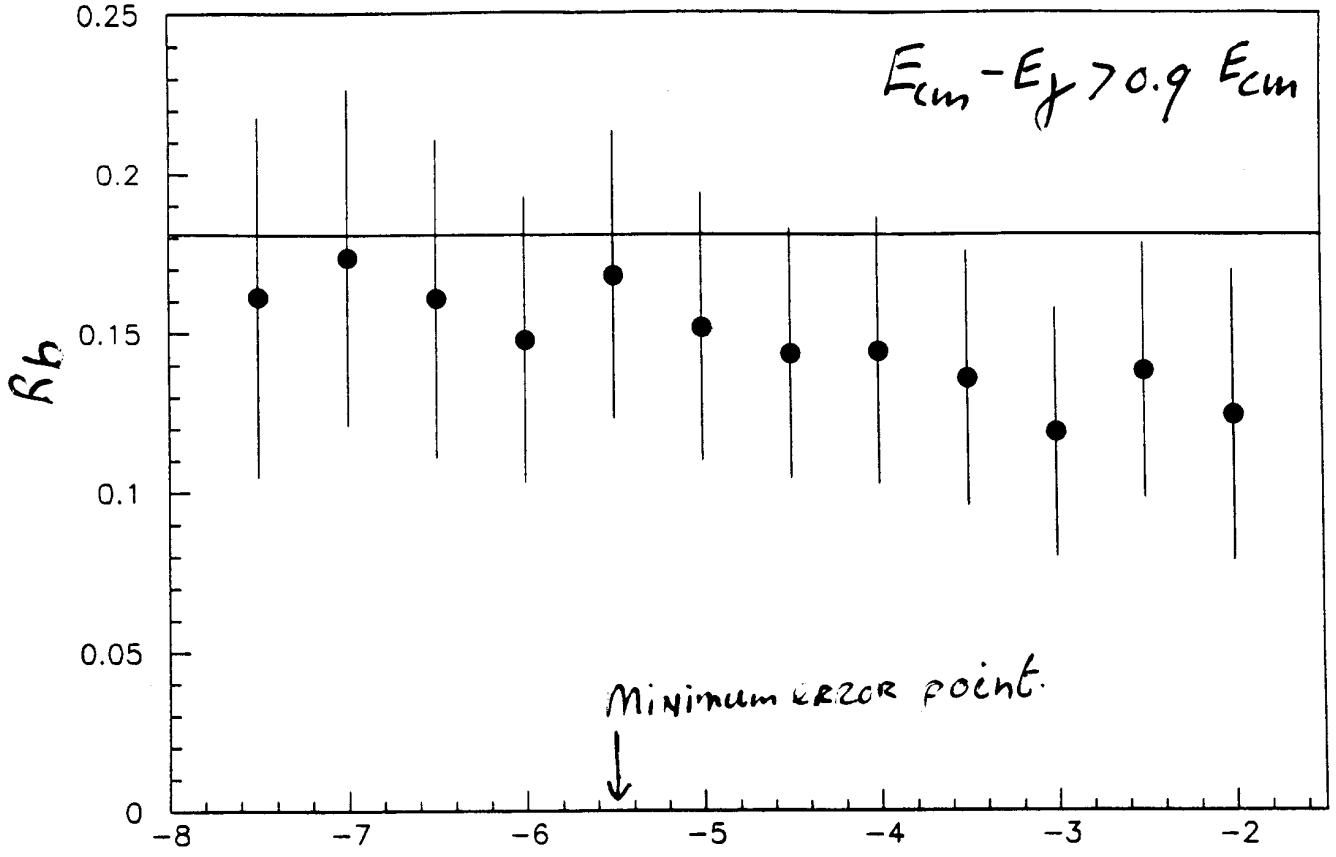
@ 130 GeV

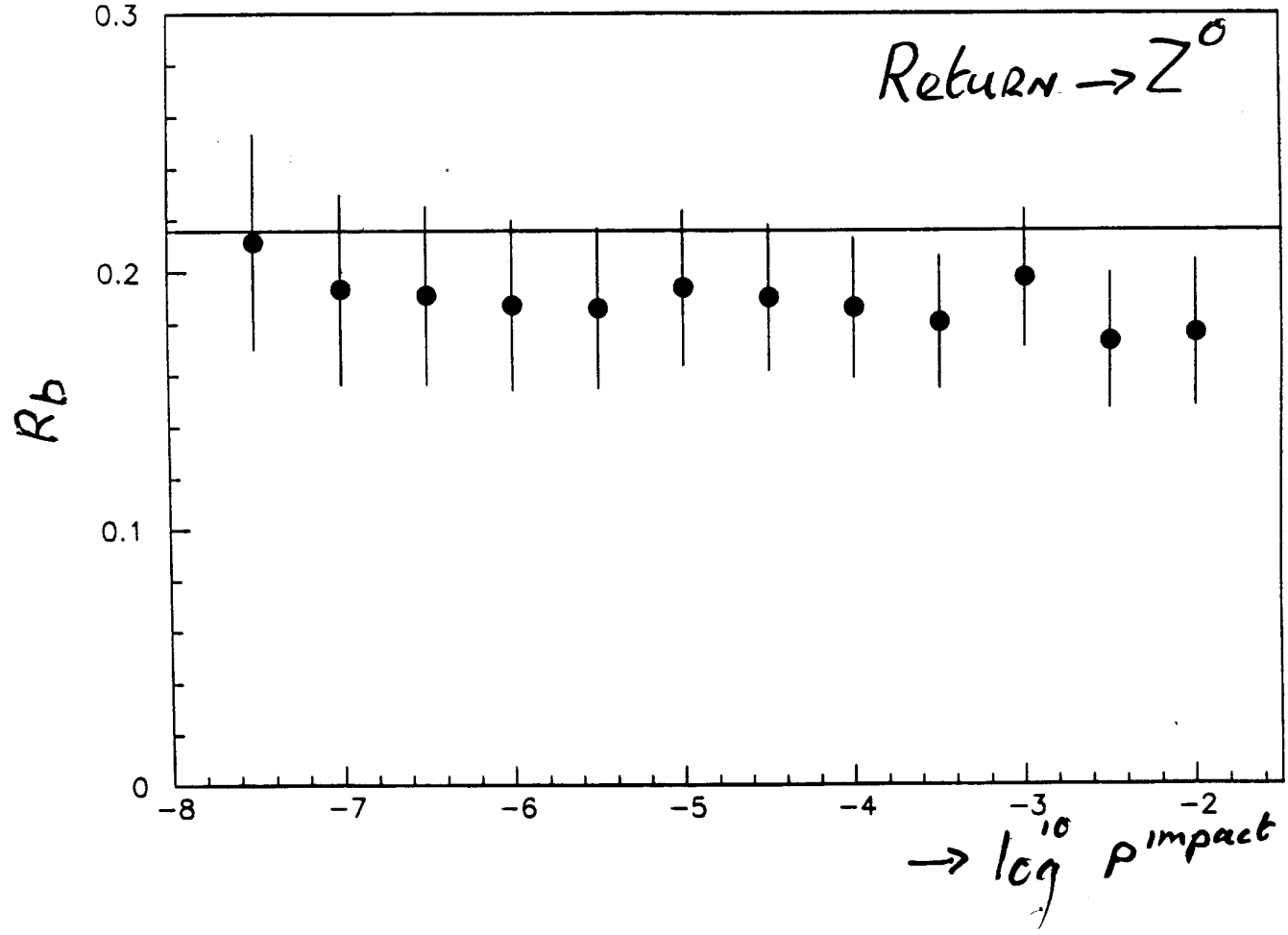
	..60.24 GeV	..65.2.. GeV	..40.2 GeV
l^+l^- (s-channel only)	0.19 % ± 0.08 %	0.19 % ± 0.08 %	0.20 % ± 0.08 %
Bhabha (t-channel only)	1.5 pb ± 0.5 pb		
two-photon collisions	10.3 pb ± 3 pb		



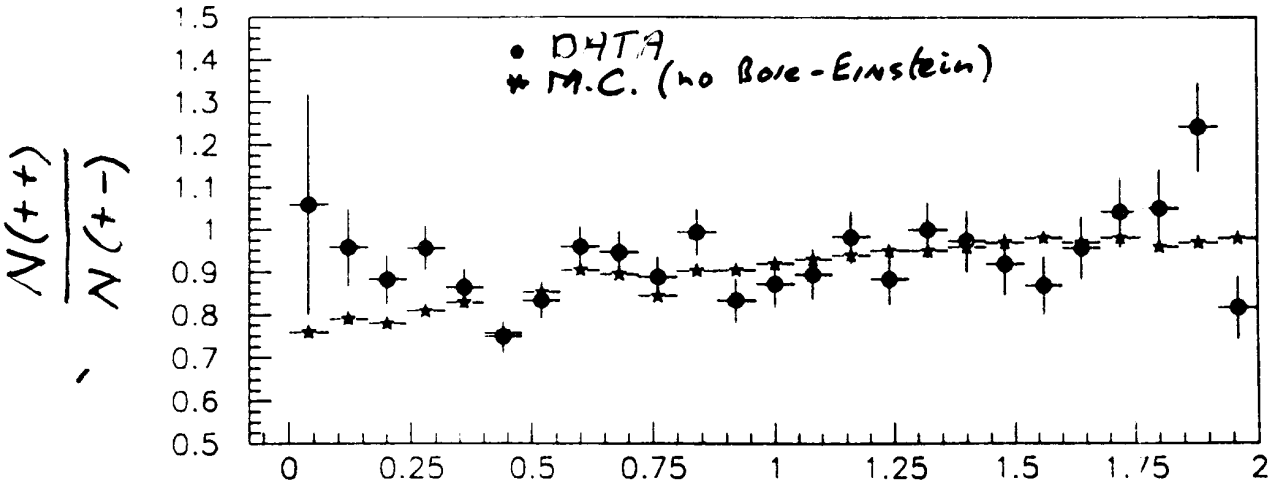
E_γ

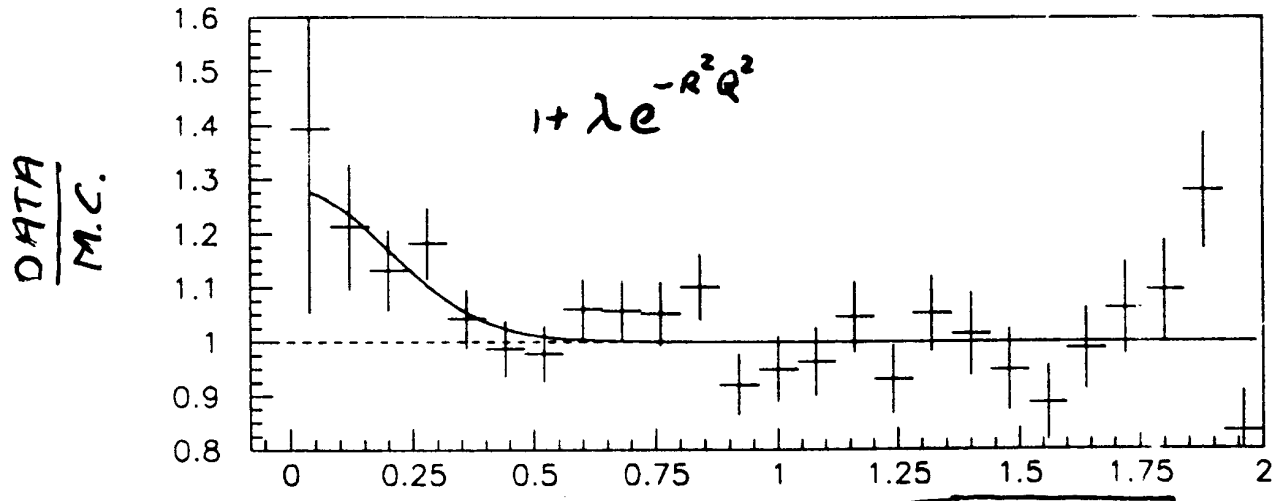
	130.24 GeV	136.21 GeV	140.2 GeV
Nb of events	908	755	13
Luminosity [pb^{-1}]	2.852	2.981	0.040
Cross-section [pb]	330	267	340
stat. error	± 12	± 10	± 95
ZFITTER	339	282	253
$R(\frac{had}{\mu\mu})$:	12.8 ± 1.8 / 13.5	13.5 ± 2.1 / 13.0	


$E_{cm} - E_\gamma > 0.9\ E_{cm}$
R_b
0.25
0.2
0.15
0.1
0.05
0
Minimum error point
-8
-7
-6
-5
-4
-3
-2


Return $\rightarrow Z^0$
R_b
0.3
0.2
0.1
0
-8
-7
-6
-5
-4
-3
-2
$\rightarrow \log_{10} \rho^{impact}$

Bose-Einstein correlations @ 130-140 GeV

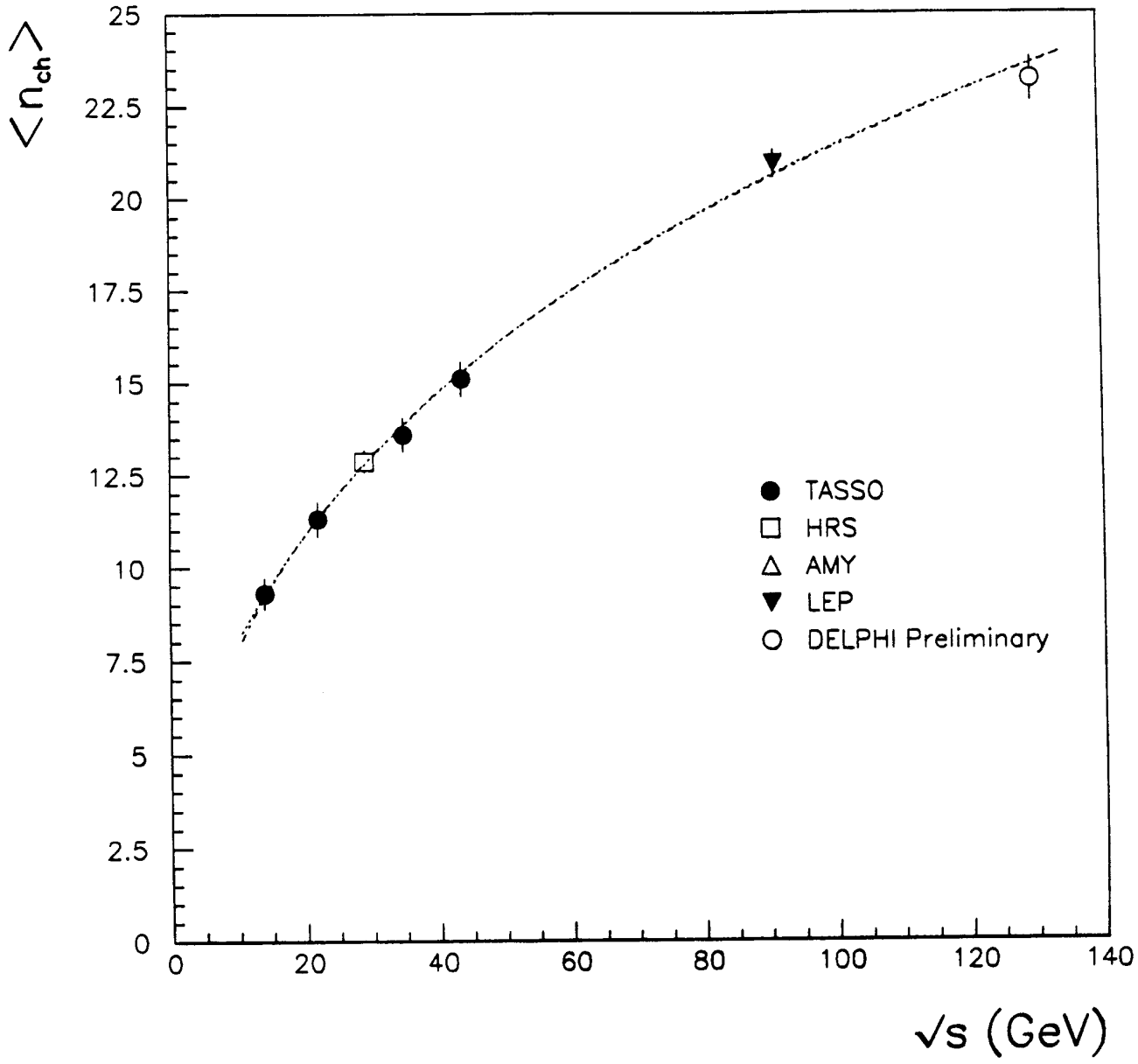


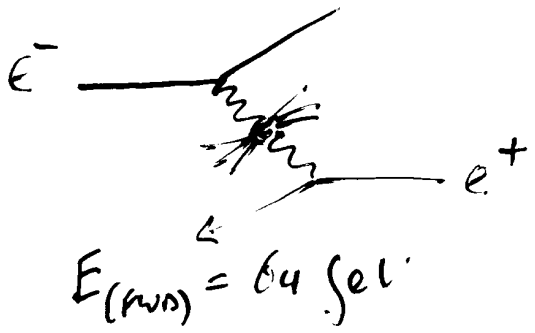


$\rightarrow Q = \sqrt{m^2_{\pi\pi} - 4m^2_\pi}$ GeV

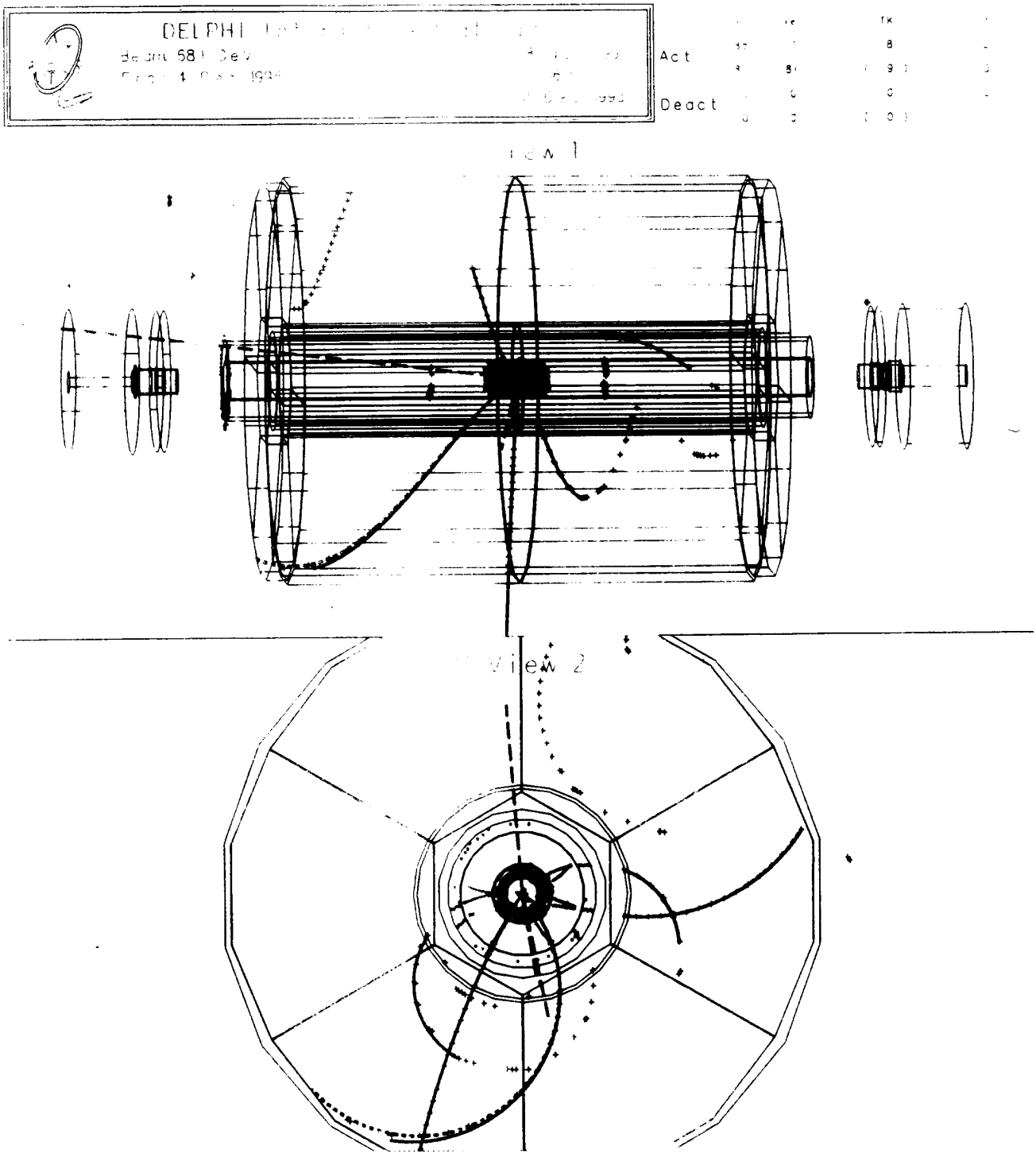
$\lambda = 0.28 \pm 0.09$ $\quad R = 0.70 \pm 0.14$ fm

(LEP1: $\lambda = 0.31 \pm 0.02$ $\quad R = 0.83 \pm 0.03$ fm)

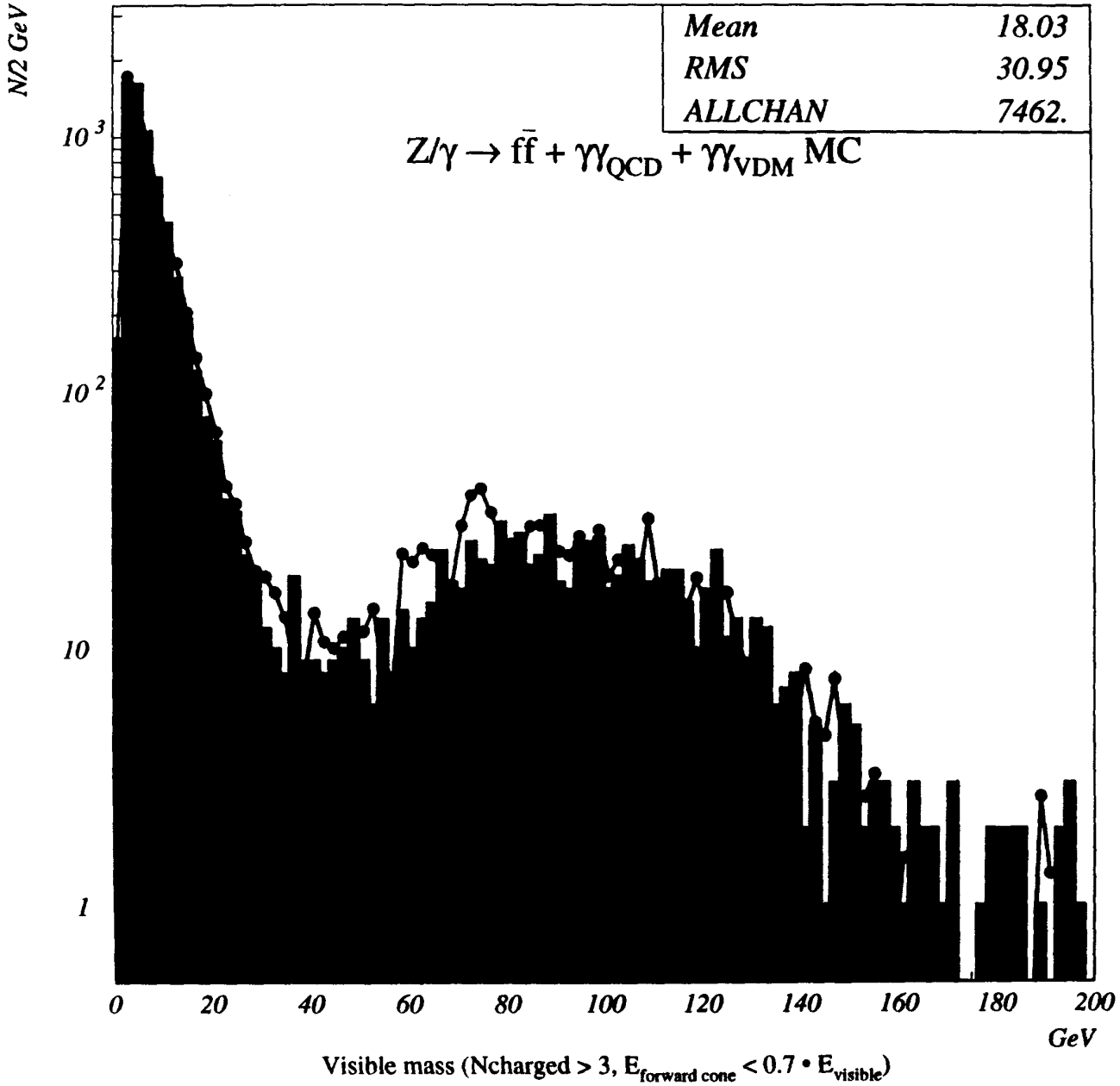

$\langle n_{ch} \rangle$
25
22.5
20
17.5
15
12.5
10
7.5
5
2.5
0
0
20
40
60
80
100
120
140
TASSO
HRS
AMY
LEP
DELPHI Preliminary
√s (GeV)



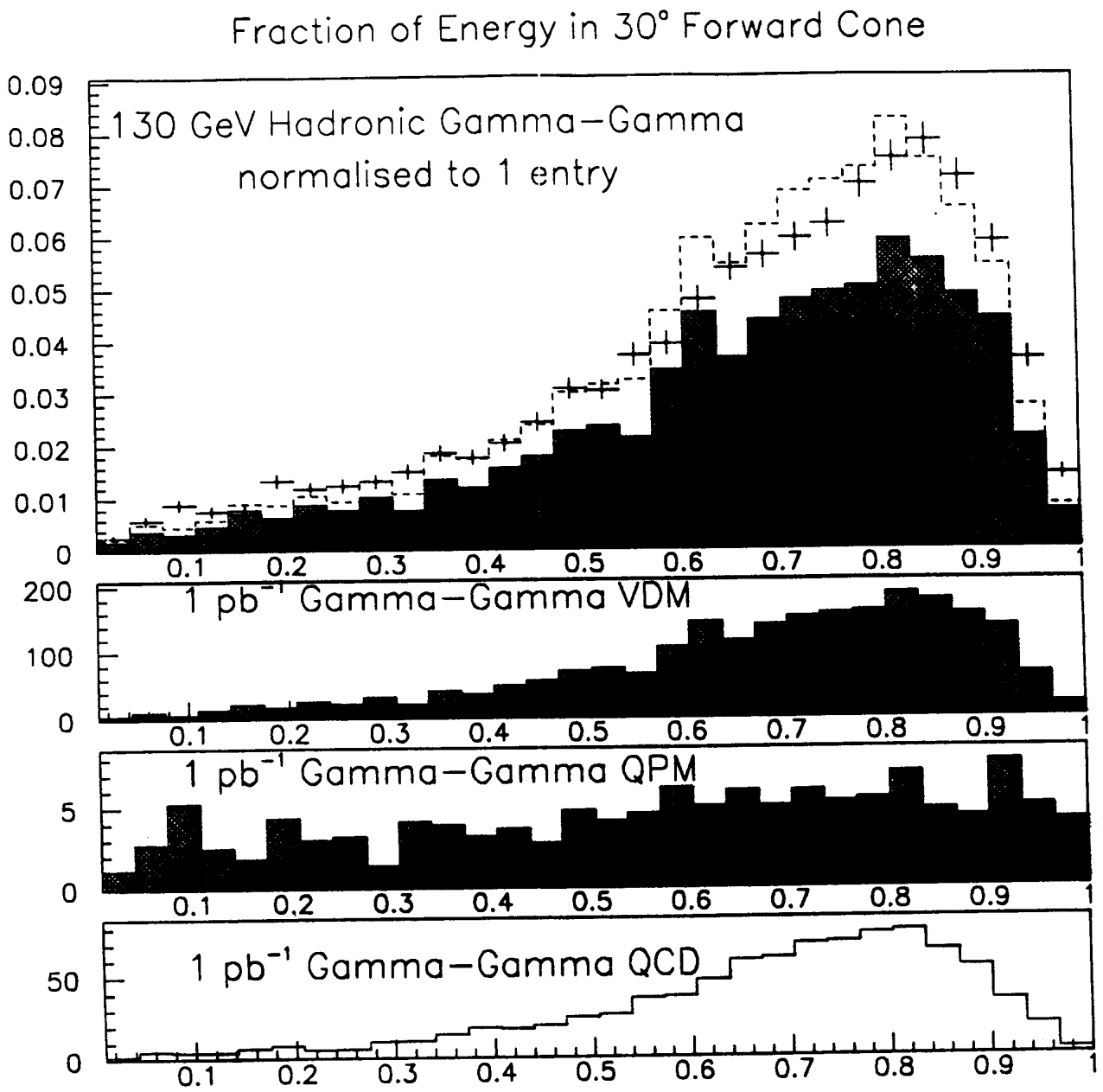
$E_{(tot)} = 64$ GeV



DELPHI ECM=130 GeV L=2.75 pb^{-1}



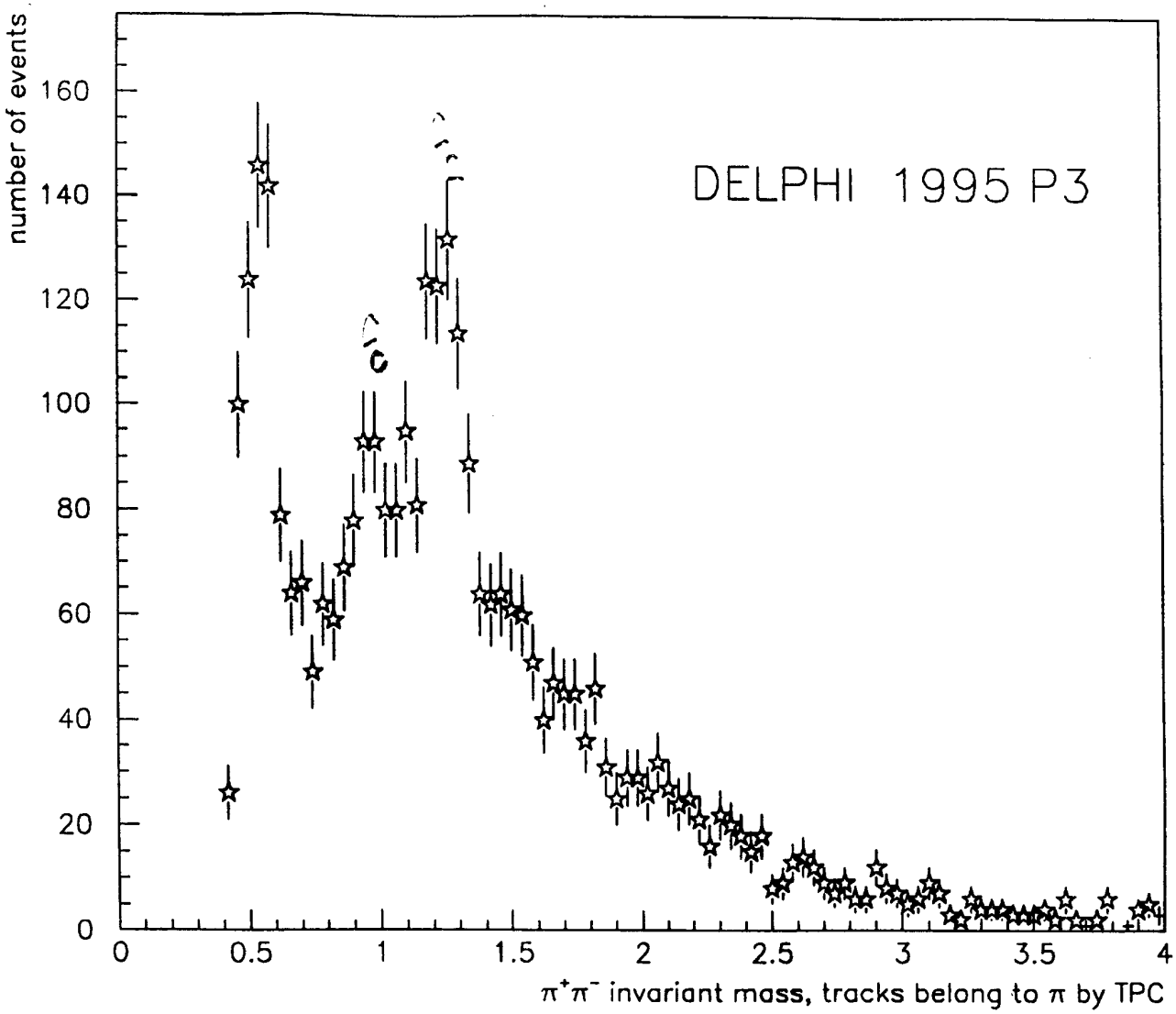
2-photon selected events



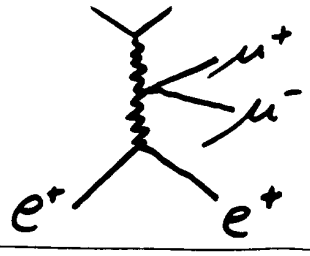
Resonant 2-γ production

- 2 charged tracks $\theta° > 10°$, $p_t > 50$ MeV/c
- dE/dx to reject $e^{\pm}$.

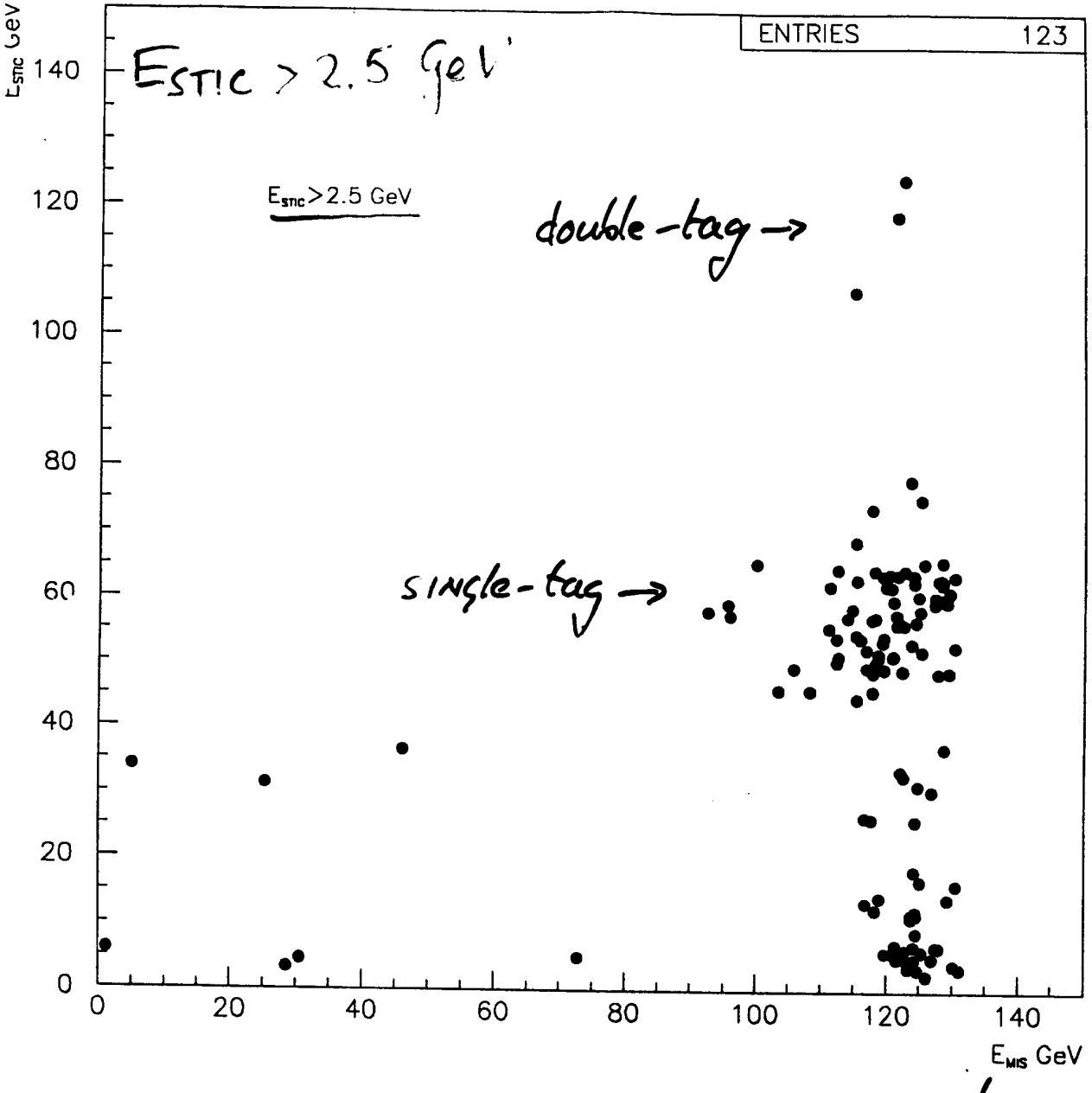
$$e^+e^- \rightarrow e^+e^- \gamma^*\gamma^* \rightarrow e^+e^- \pi^+\pi^-$$



$m_{\pi^+\pi^-}$

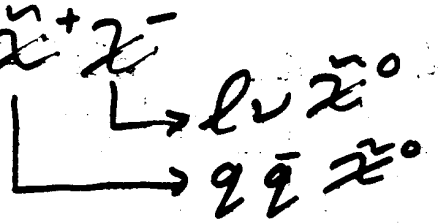


$e^+e^- \to e^+e^-\mu^+\mu^-$



$\sqrt{s} - E_{\mu_1} - E_{\mu_2}$

Search for $e^+e^- \to \tilde{\chi}^+\tilde{\chi}^-$



4 jets (also if $\tilde{\chi}^\pm \to b\tilde{t}$)

- Multiplicity > 10, no isolated l (20°)
- $\gamma\gamma$ rejection: $P_t > 5$, $30 < \theta < 150°$, $E_{FWD} < 45\%$
- Z, WW rejection: $E_{VIS} < 65$, $M_{VIS} < 60$,
  $A_{col} < 140$, $20 < A_{lop} < 140$, $E_j < 10$

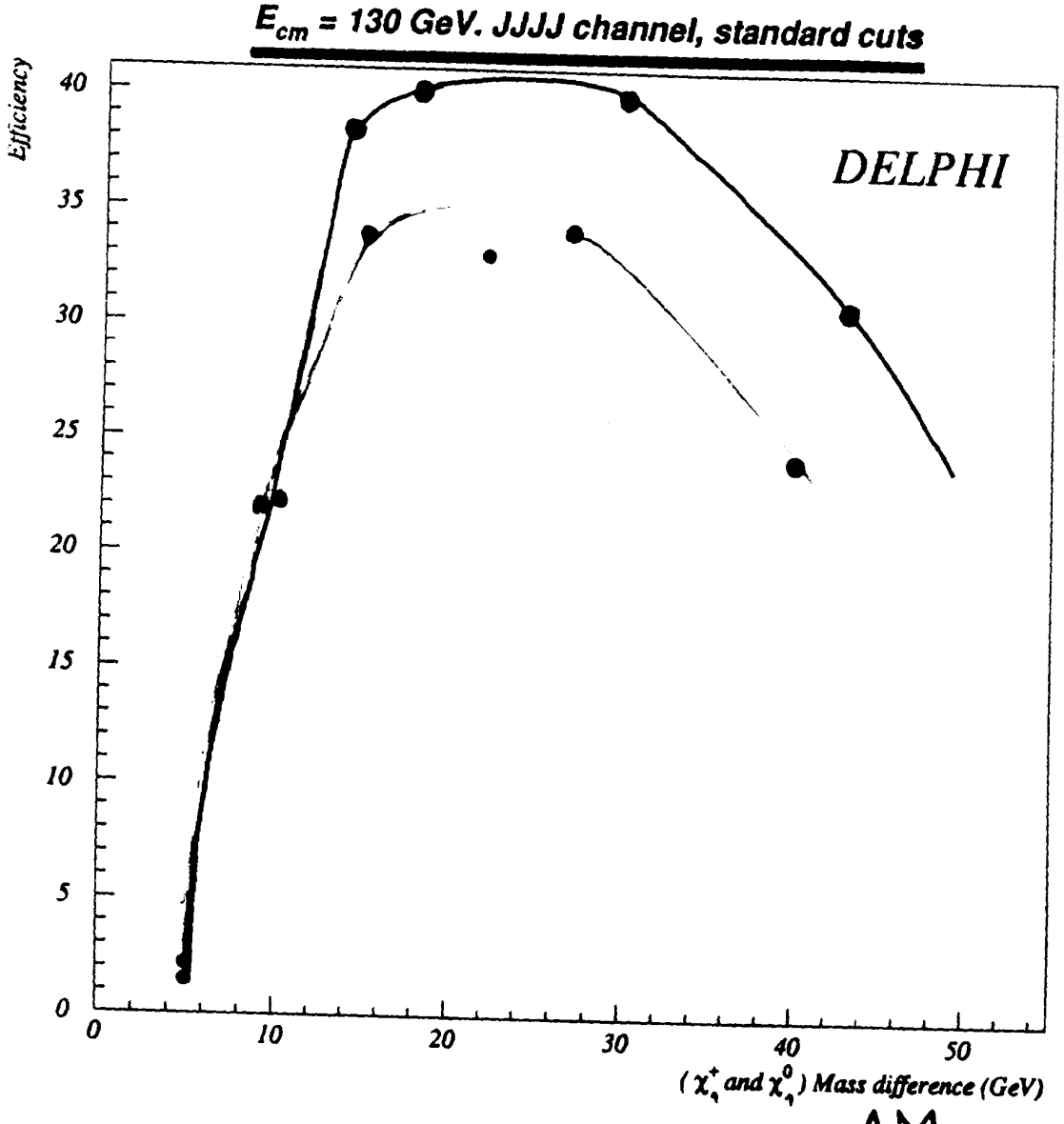
2 jets + lepton: $\Delta M(\tilde{\chi}^\pm \to \tilde{\chi}^0) > (<)\ 20$ GeV

- Multiplicity > 10, lepton ($150 > 20°$), $3(1) < P_l < 38$.
- $\gamma\gamma$ rejection: $P_t > 5\ (2)$, $20 < \theta_{lp} < 160$, $E_{FWD} < 45\%$ (20%)
- Z^0, WW rejection: $M_{VIS} < 65\ (20)$, $M_{hadr} < 42$
  $A_{col} < 170$, $A_{copl} < 170$

2 leptons:

- $N_{charged} = 2$, $20° < \theta < 160$, $P > 0.5$
- $E^{max}_{neut} < 5$, $E_{VIS} < 70$, $E_{FWD}/E_{VIS} < 20\%$
  $10° < A_{copl} < 170°$, $P_T > 2.5$

JJJJ

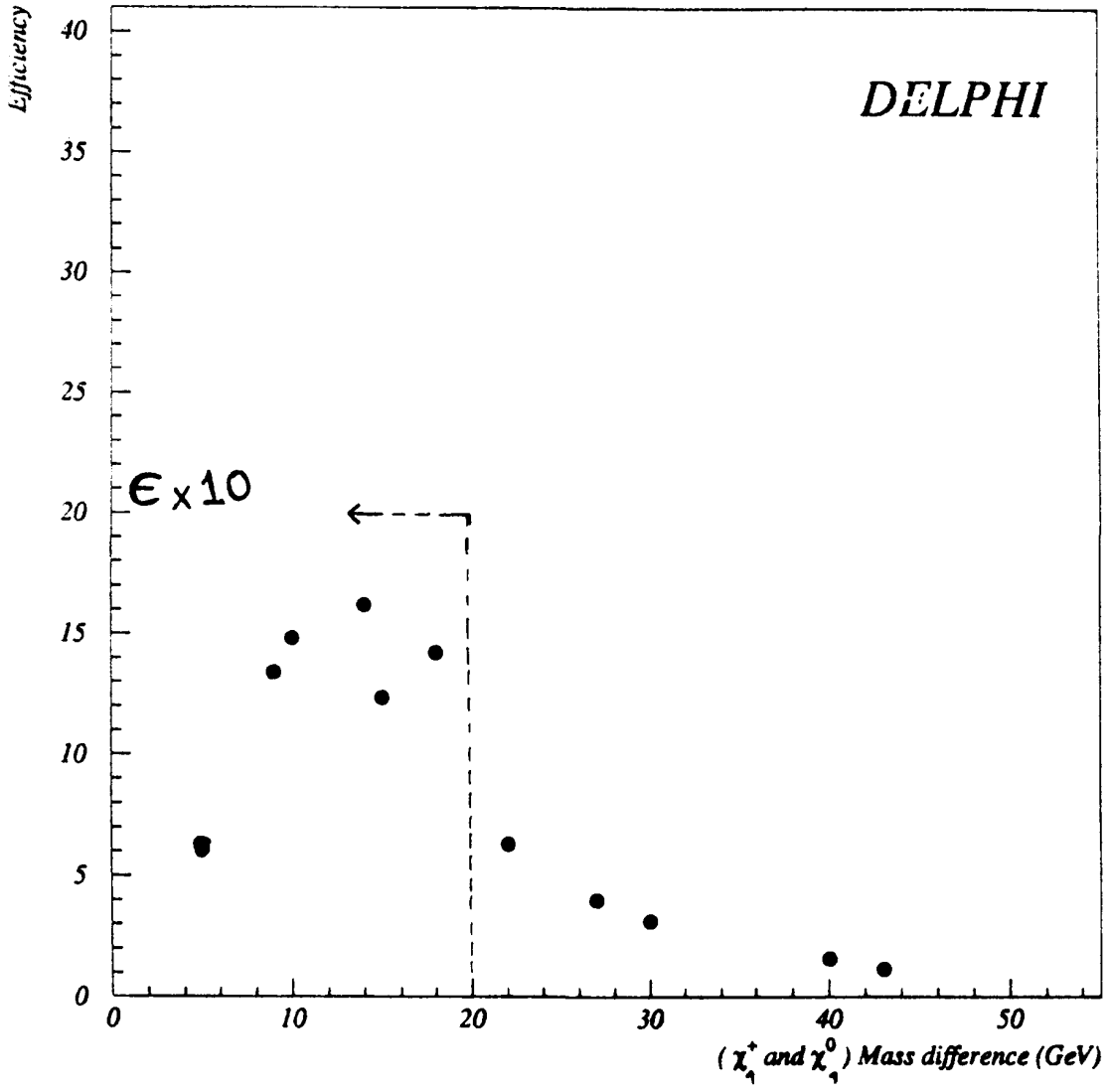


—— $\tilde{\chi}_1^+$ ~ 64 GeV

—— $\tilde{\chi}_1^+$ ~ 54 GeV

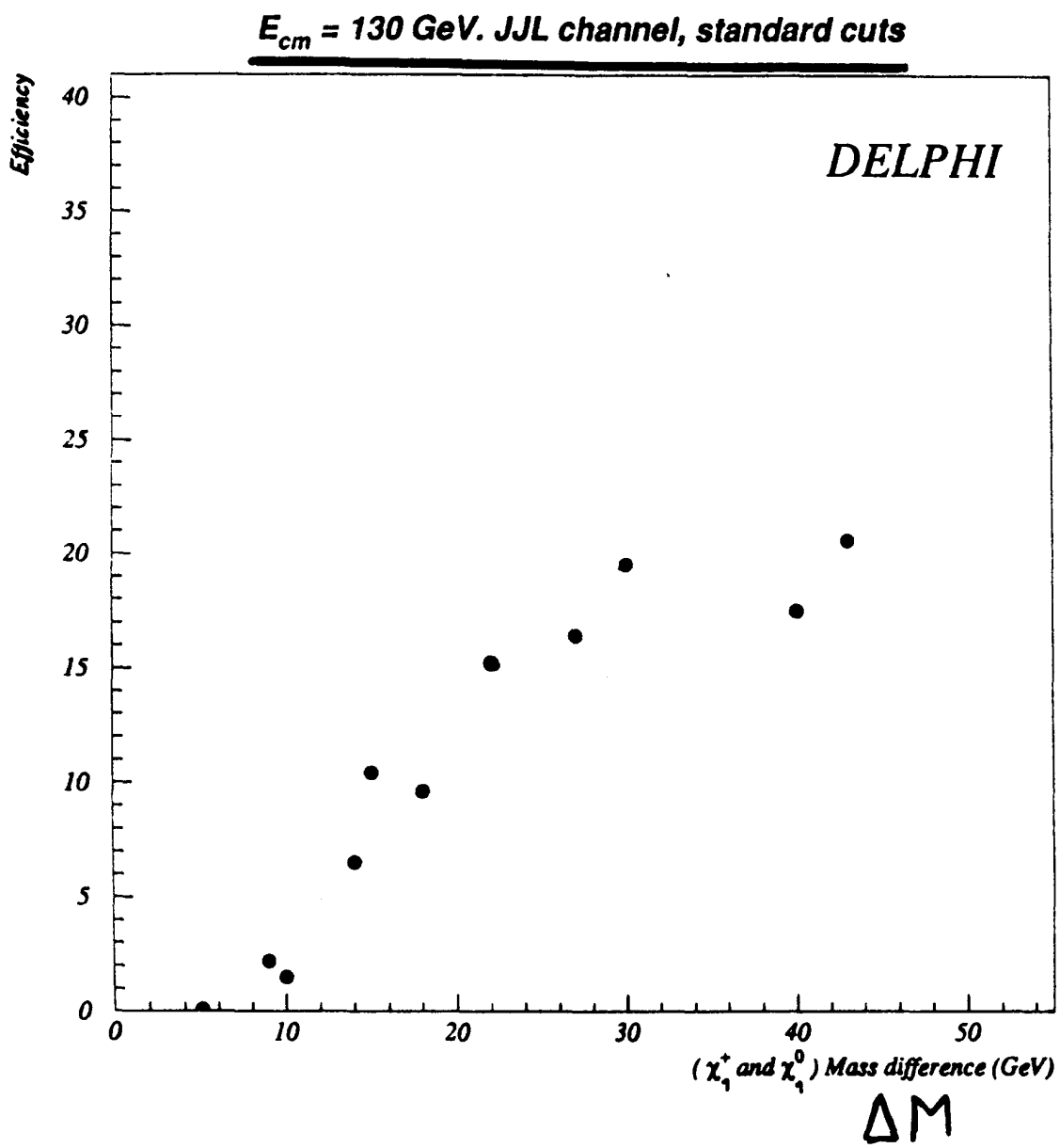
● DEGENERATED SCENARIO

E_{cm} = 130 GeV. JJL channel, degenerated scenario cuts



● STANDARD CUTS (DAFNE)

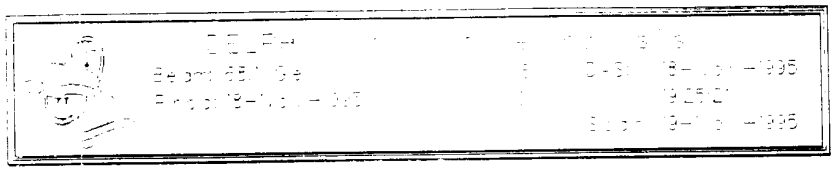
JJL

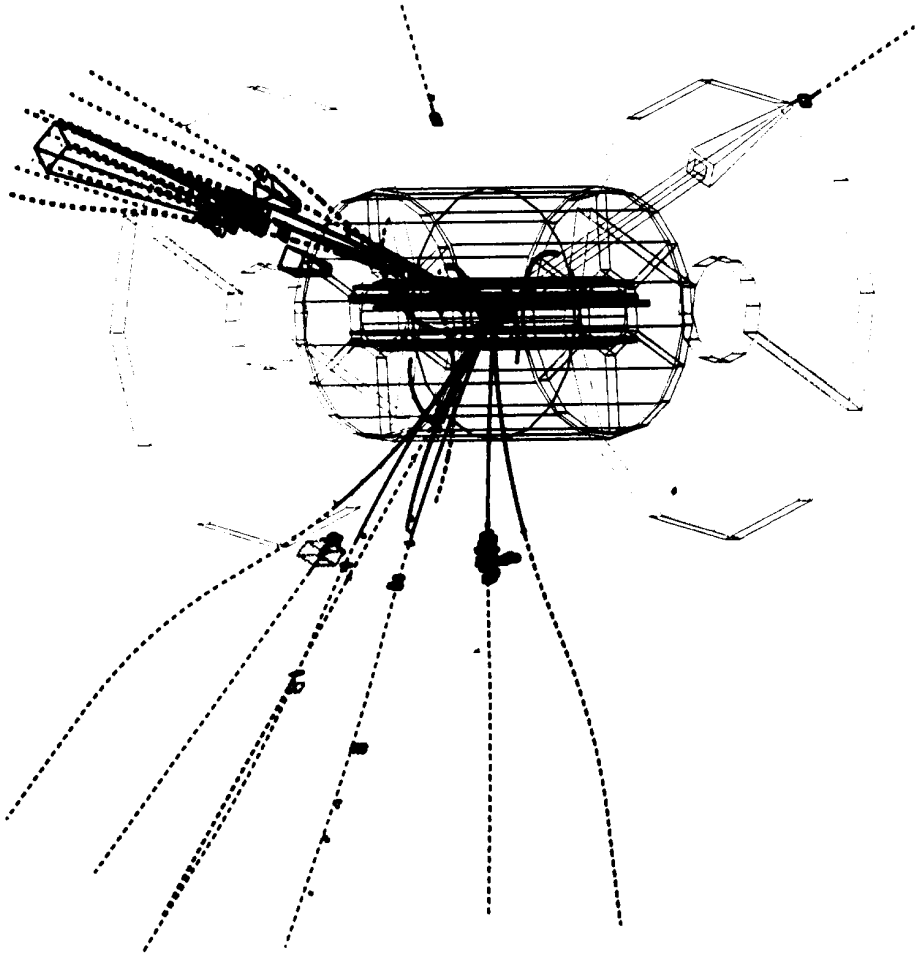


ΔM

12 SUSY POINTS,

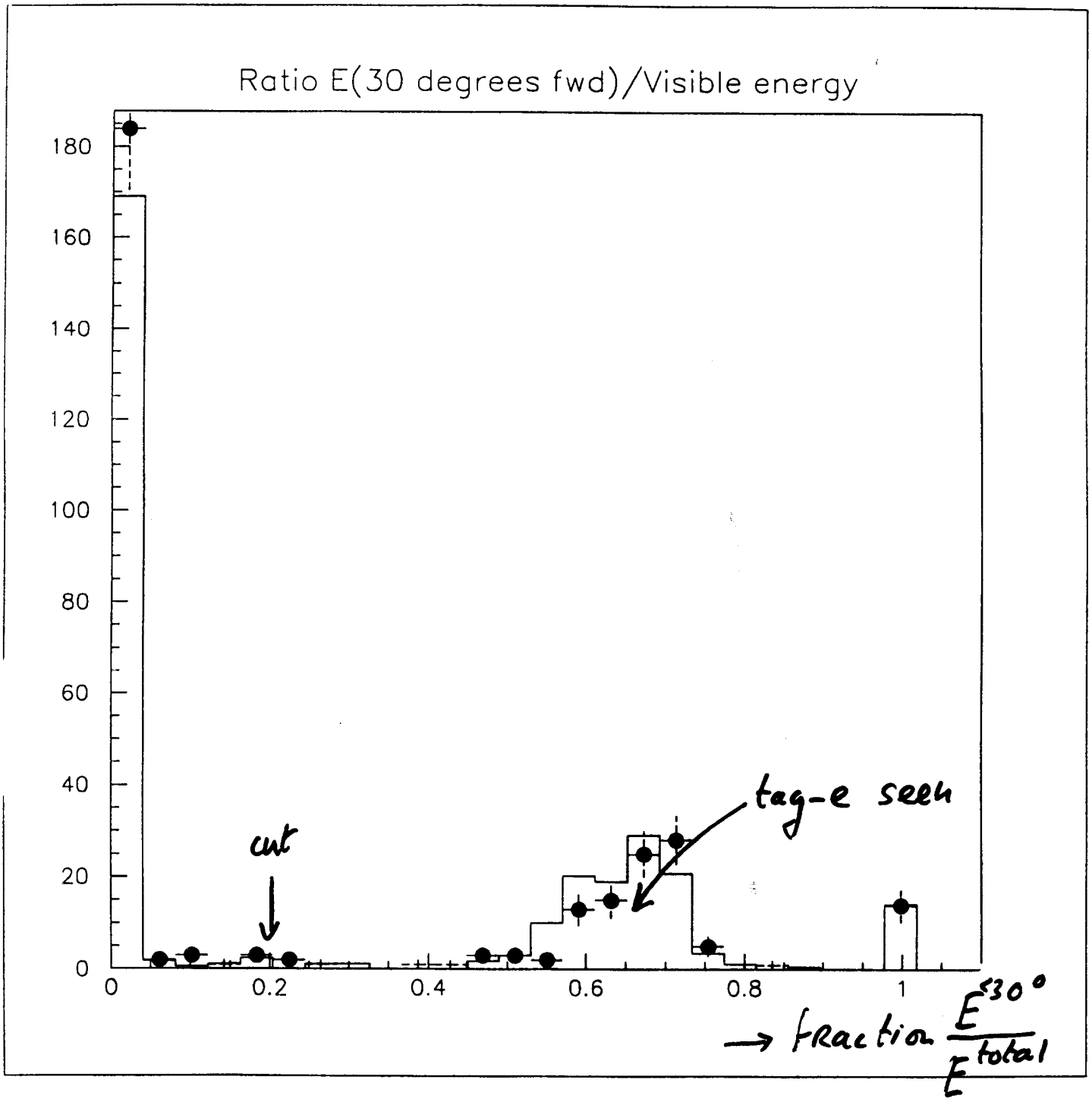
FULL **DELPHI** SIMULATION.





- 2l analysis

-

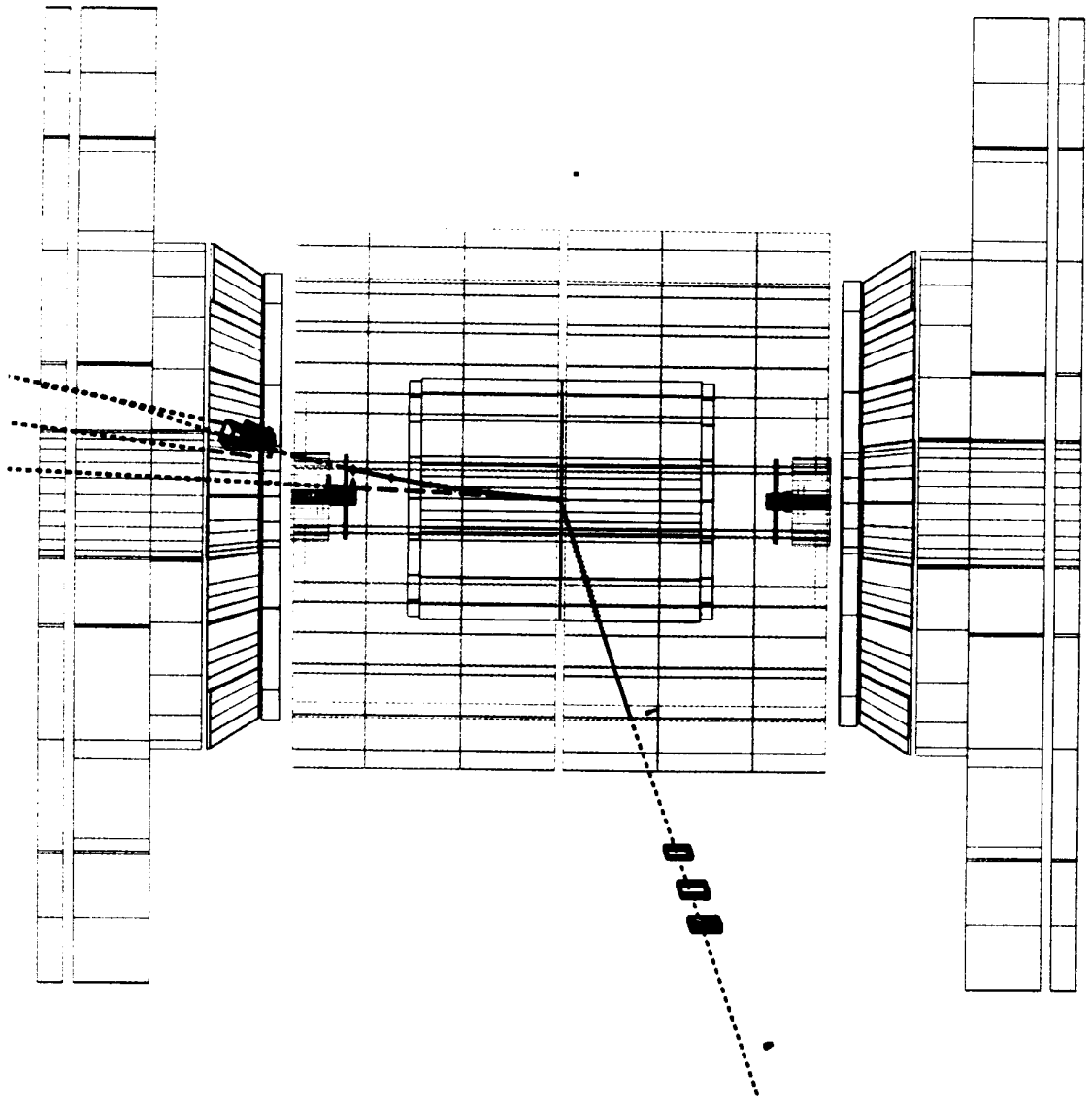

Ratio E(30 degrees fwd)/Visible energy
180
160
140
120
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
cut
tag-e seen
→ fraction $\frac{E^{<30°}}{E^{total}}$

DELPHI [illegible] Analysis

Beam: 65.2 GeV
Prod: 30-Nov-1995

DAS: 4-Nov-1995 22:34:38
Scan: 8-Dec-1995

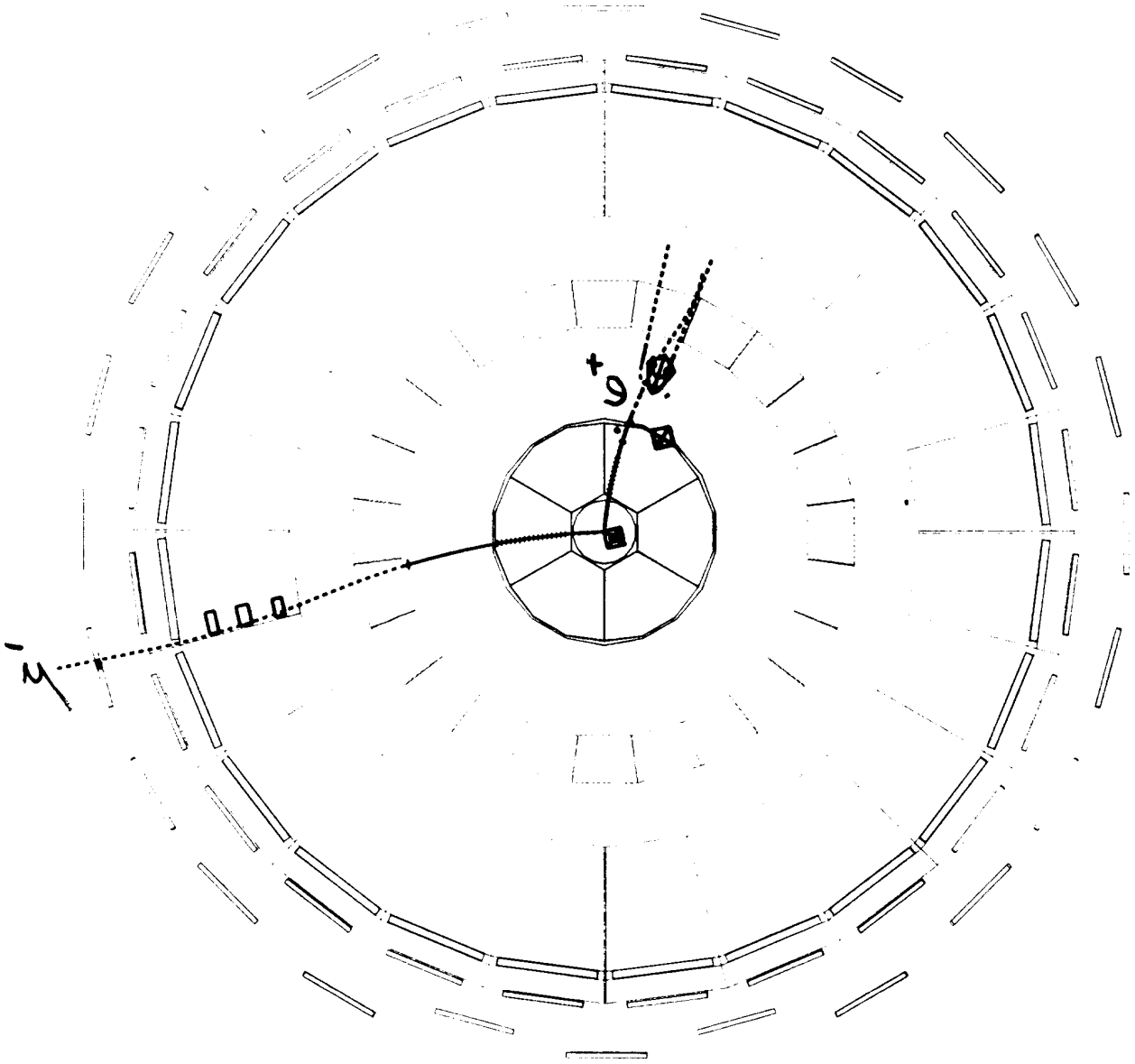
	TD	TE	TK	T.	ST
Act	1	21	5	2	0
	(119)	(30)	(5)	[illegible]	(0)
Deact	0	0	0	2	0
	(0)	(1)	(2)	[illegible]	(0)

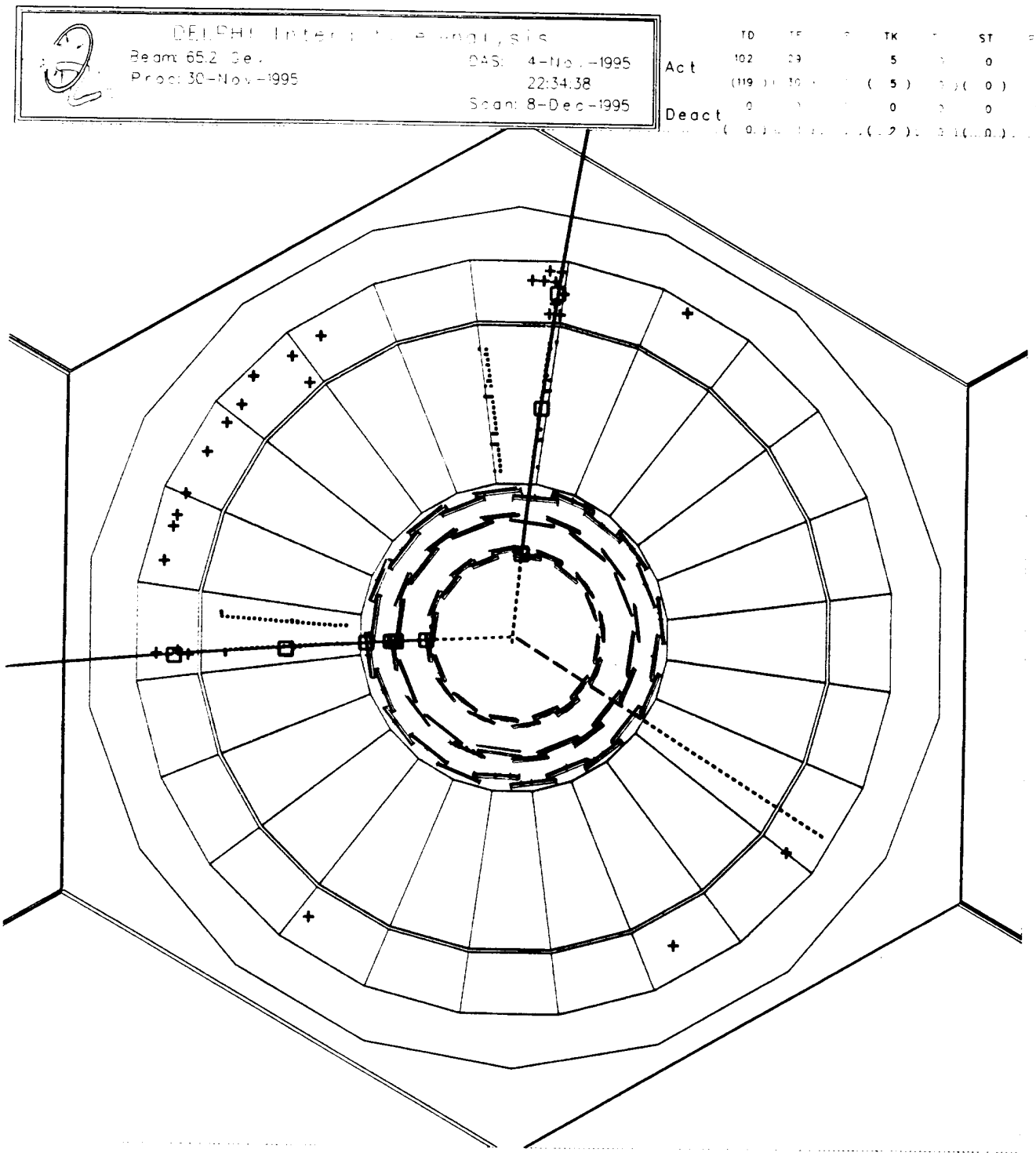


DELPHI Interactive Analysis

Beam: 65.2 GeV
Proc: 30-Nov-1995
DAS: 4-Nov-1995 22:34:38
Scan: 8-Dec-1995

	TD	TE	TK	ST
Act	1	30	5	0
	119	30	(5)	(0)
Deact	0	0	0	0
	0	0	(2)	(0)




DELPHI Interactive Analysis
Beam: 65.2 GeV
Proc: 30-Nov-1995
DAS: 4-Nov-1995
22:34:38
Scan: 8-Dec-1995
TD TF TK ST
Act 102 23 5 0
(119) (30) (5) (0)
Deact 0 0 0
(0) (2) (0)

λ_1 [illegible]

1. [illegible]URE HIGGS NO SCENARIO.
2. σ [illegible]COMPUTED WITH SUSYGEN.

$\Delta M > 10$ GeV

	JJL	JJJJ	LL
Efficiencies	0.2	0.32	0.06
# background (MC)	0.1[illegible]	0.15	0.02
* candidates	0	0	0
Limit 95% CL	3	3	3

$\mathcal{L} = 5.92\ pb^{-1}$ $\quad \sigma_{MAX}(130.4\ GeV) = 0.87\ pb \rightarrow M_{\tilde{\chi}_1^\pm} > 64.8$

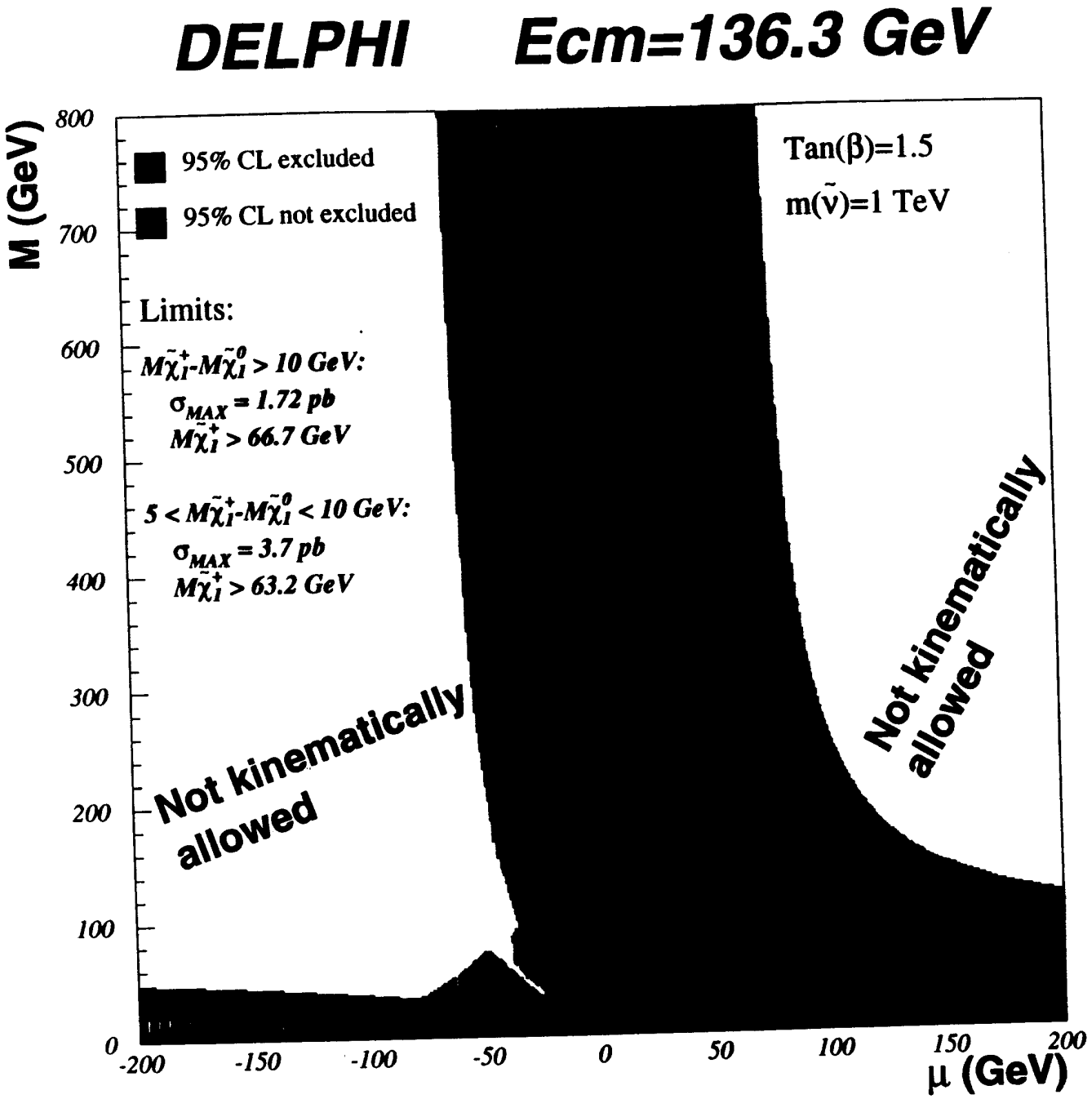
$\mathcal{L} = 3.01\ pb^{-1}$ $\quad \sigma_{MAX}(136.3\ GeV) = 1.72\ pb \rightarrow M_{\tilde{\chi}_1^\pm} > 66.7$ Ge

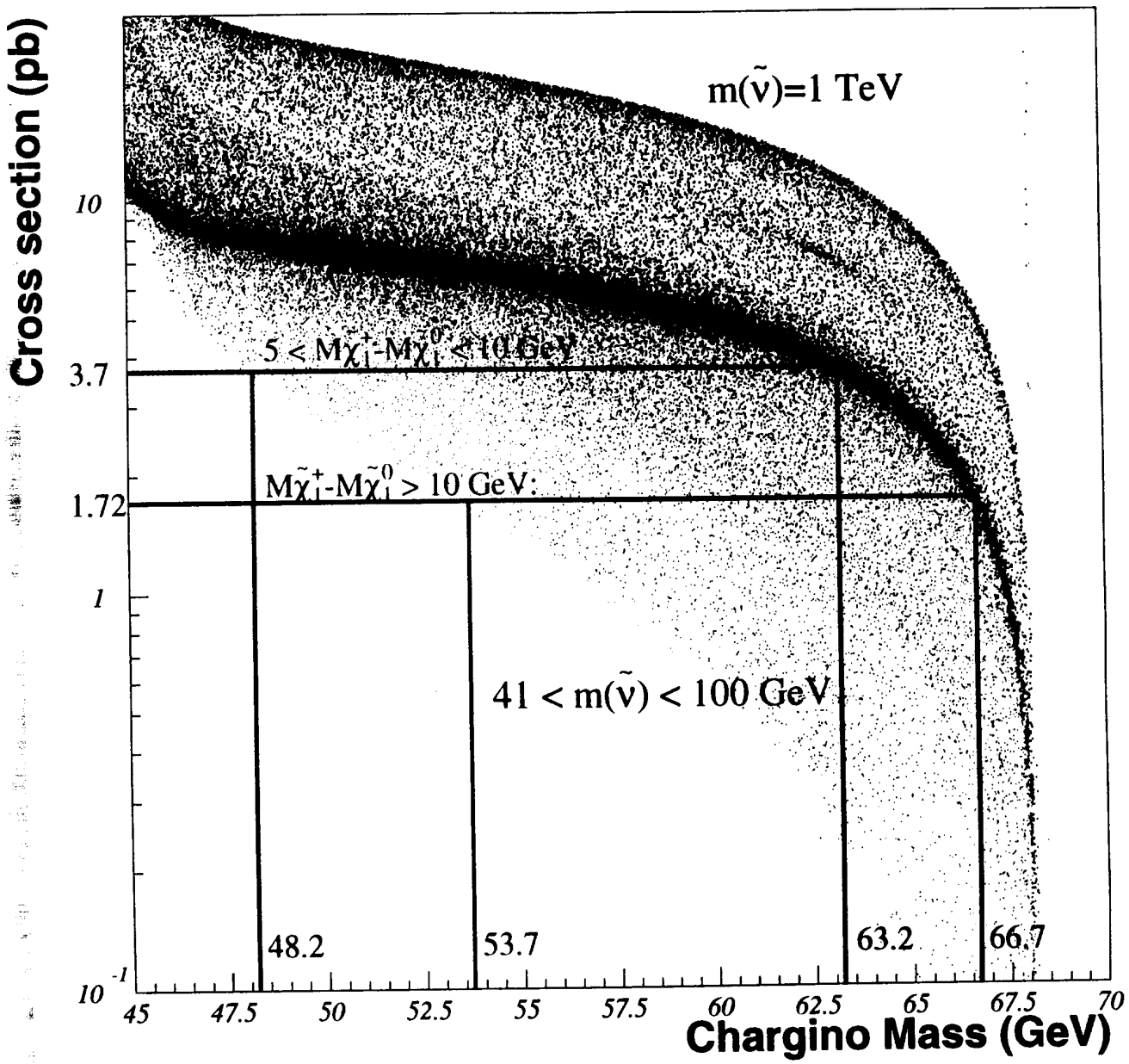
$5 < \Delta M < 10$

	JJL	JJJJ	LL
Efficiencies	0.1	0.07	0.03
* candidates (M.C.)	0 (0)	0 (0.15)	0 (0.4)
Limit 95% CL	3	3	3

$\sigma_{MAX}(130.4\ GeV) = 2.53\ pb \rightarrow M_{\tilde{\chi}_1^\pm} > 63.2$

$\sigma_{MAX}(136.3\ GeV) = 4.98\ pb \rightarrow M_{\tilde{\chi}_1^\pm} > 60.0$


DELPHI Ecm=136.3 GeV
M (GeV)
800
700
600
500
400
300
200
100
0
95% CL excluded
95% CL not excluded
Limits:
$M\tilde{\chi}_1^+ - M\tilde{\chi}_1^0 > 10$ GeV:
$\sigma_{MAX} = 1.72$ pb
$M\tilde{\chi}_1^+ > 66.7$ GeV
$5 < M\tilde{\chi}_1^+ - M\tilde{\chi}_1^0 < 10$ GeV:
$\sigma_{MAX} = 3.7$ pb
$M\tilde{\chi}_1^+ > 63.2$ GeV
Tan(β)=1.5
$m(\tilde{\nu})$=1 TeV
Not kinematically allowed
Not kinematically allowed
-200
-150
-100
-50
0
50
100
150
200
μ (GeV)


DELPHI Ecm=136.3 GeV
Cross section (pb)
m(ν̃)=1 TeV
10
3.7
5 < Mχ̃₁⁺-Mχ̃₁⁰ < 10 GeV
Mχ̃₁⁺-Mχ̃₁⁰ > 10 GeV:
1.72
1
41 < m(ν̃) < 100 GeV
48.2
53.7
63.2
66.7
10⁻¹
45
47.5
50
52.5
55
57.5
60
62.5
65
67.5
70
Chargino Mass (GeV)

Search for $e^+e^- \to \tilde{\chi}_1^0 \tilde{\chi}_2^0$

$\tilde{\chi}_2^0 \to \tilde{\chi}_1^0 l\bar{l}$

$e^+e^- \to \tilde{\chi}_2^0 \tilde{\chi}_2^0$

$\tilde{\chi}_2^0 \to \tilde{\chi}_1^0 l\bar{l}$

$\tilde{\chi}_2^0 \to \tilde{\chi}_1^0 l\bar{l}$

Cuts: $\not{E} > 90$ GeV, 2 isolated tracks,

$A_{col} < 172$, $A_{cop} < 170$

$N_{track} > 1$ GeV < 5

~~$\not{p}_T$~~ $45 < \theta_{miss} < 135$, $\not{p}_T > 3$ OR $E_T > 11$

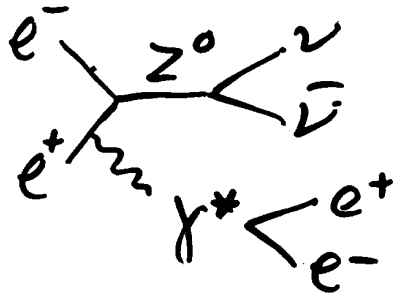
$4l + \not{E}$: no candidates

$2l + \not{E}$: 1 candidate

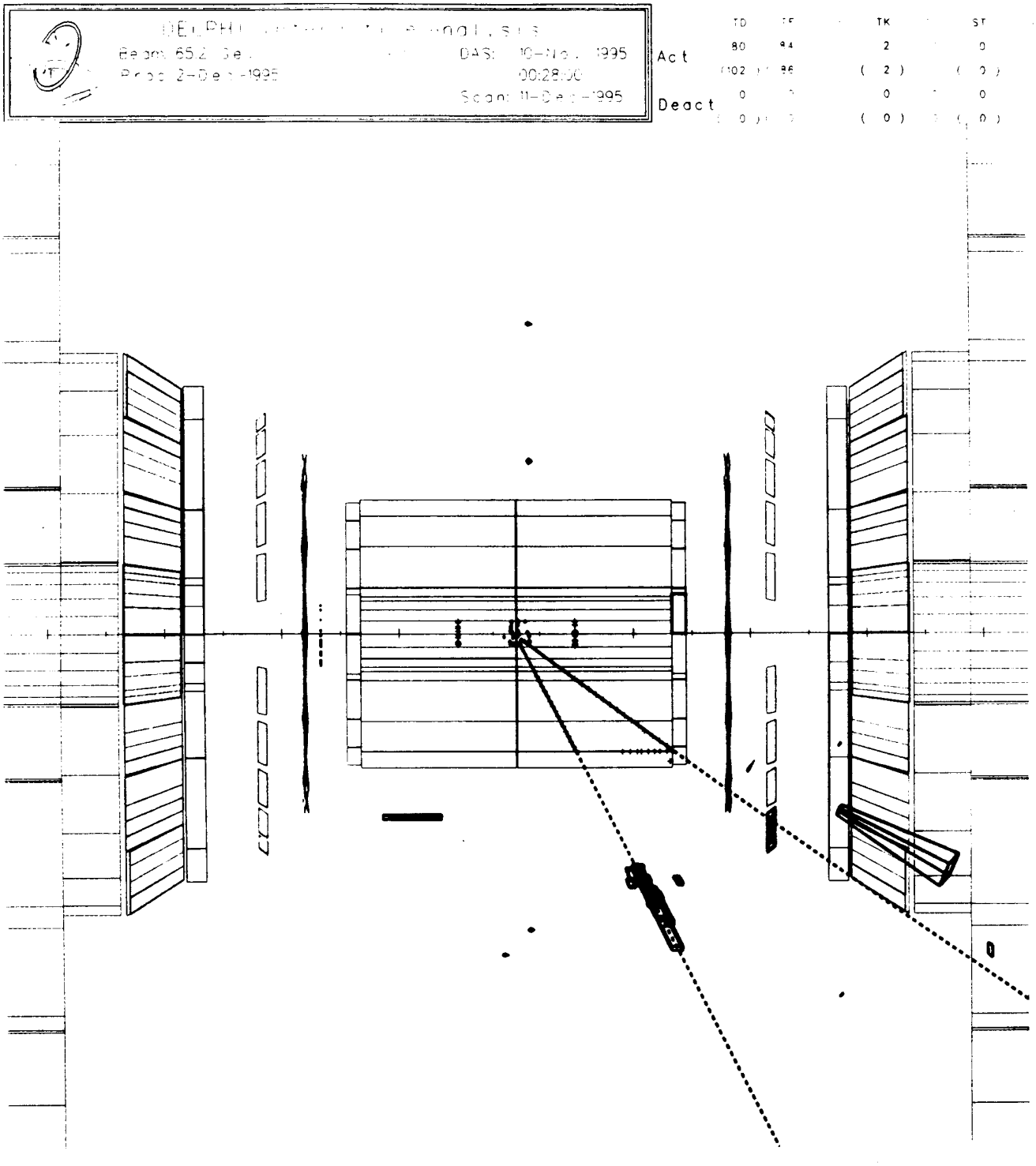
$m(ll) = 4.6$

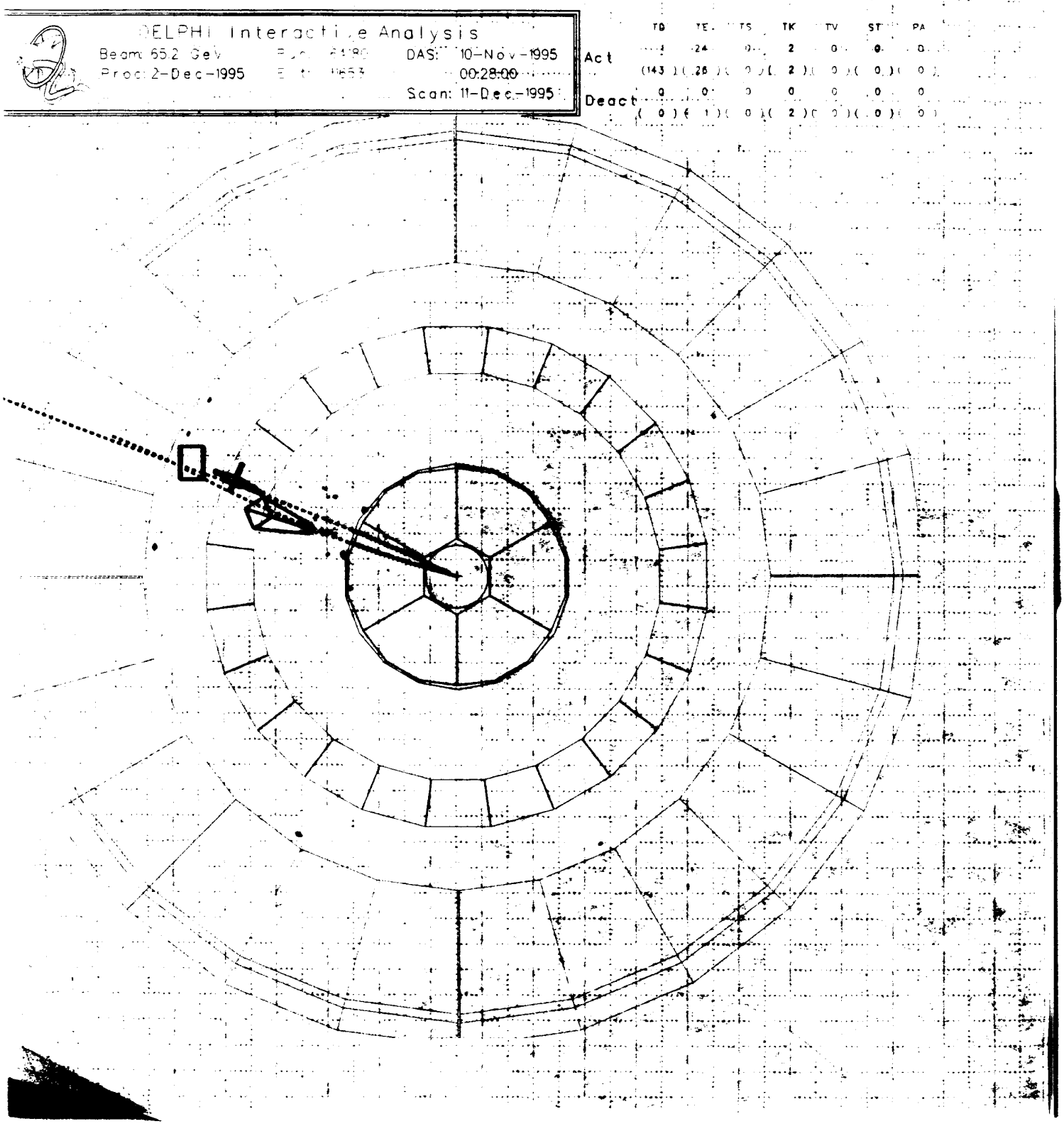
$m_{miss} = 109.3$

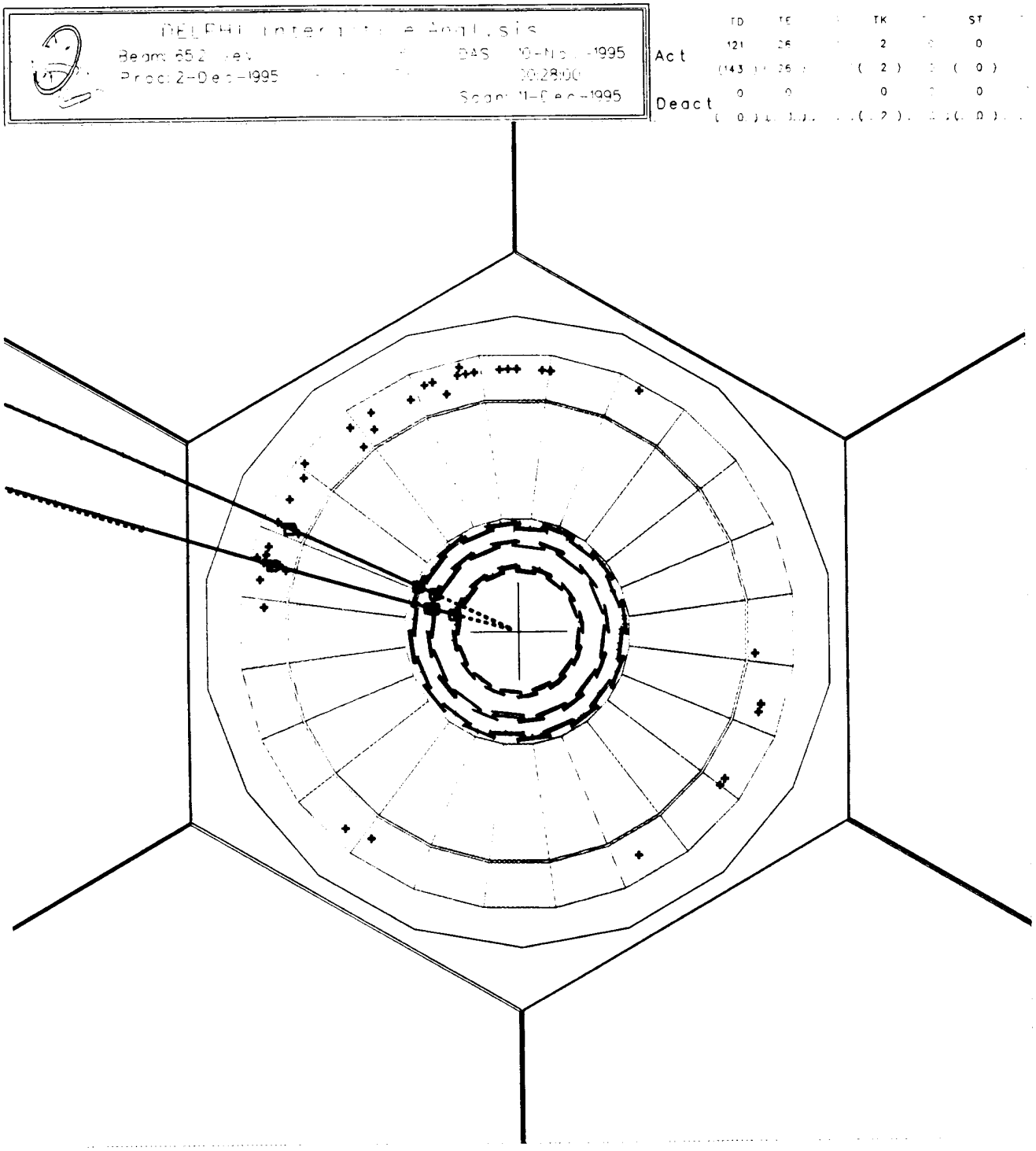
$p_t^{miss} = 15.3$

OR: 

Expect 0.2 events (Not full sim.


DELPHI
Beam 65.2 GeV
Prod 2-Dec-1995
DAS: 10-Nov-1995
00:28:00
Scan: 11-Dec-1995
TD TF TK ST
Act 80 94 2 0
(102) (96) (2) (0)
Deact 0 0 0 0
(0) (0) (0) (0)


DELPHI Interactive Analysis
Beam: 65.2 GeV
Proc: 2-Dec-1995
DAS: 10-Nov-1995
00:28:00
Scan: 11-Dec-1995
TD TE TS TK TV ST PA
Act
(143) (28) (0) (2) (0) (0) (0)
Deact
0 0 0 0 0 0 0
(0) (1) (0) (2) (0) (0) (0)


DELPHI Interactive Analysis
Beam 652 rev.
Prod: 2-Dec-1995
DAS 10-Nov-1995
20:28:00
Scan: 11-Dec-1995
TD TE TK ST
Act 121 26 2 0
(143) (26) (2) (0)
Deact 0 0 0 0
(0) (0) (2) (0)

SELECTION FOR $\tilde{t}_1\tilde{t}_1 \to c\bar{c}\,\chi\,\chi$ (acoplanar jets)

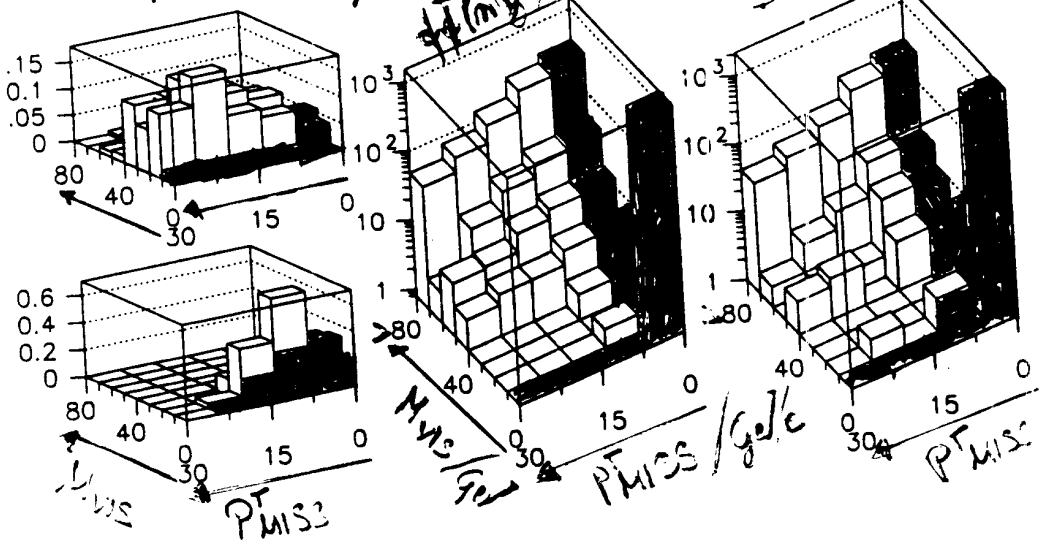
☑ MULTIHADRONS, $\sum_{\theta<30^\circ} E < 0.1\, E_{CH.}$

☑ M_{VIS} VS. $P_{T\,MISS}$:

$M(\tilde{t},\tilde{\chi}^0)$

(55,35)

(51,41)

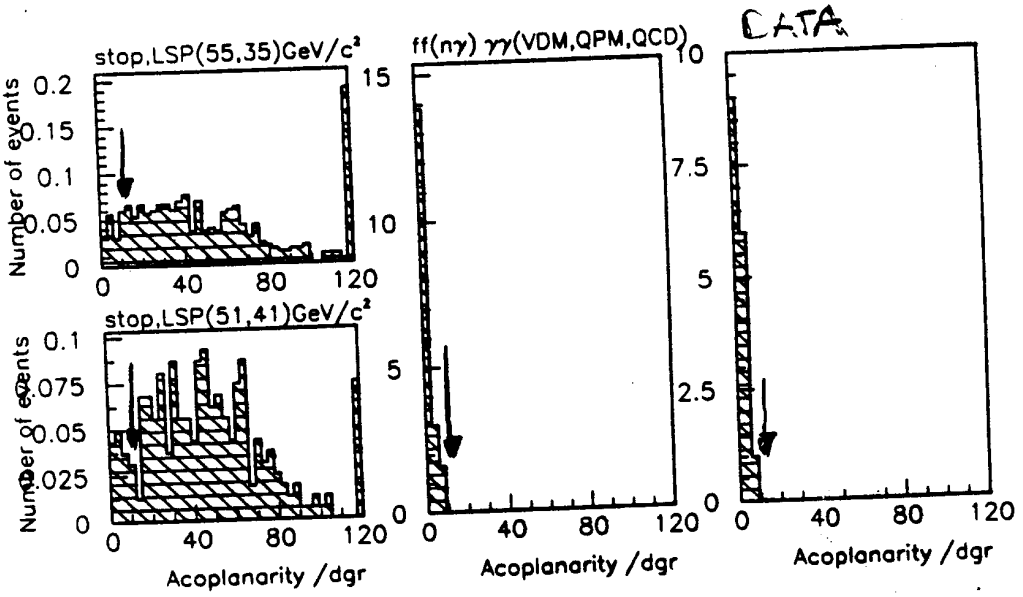


☑ $M_{VIS} < 0.5\, E_{CM}$, $M_{MIS} > 0.5\, E_{CM}$, #JETS < 3, NO ISOLATED PARTICLES

☑ acoplanarity > 10°

(55,35)

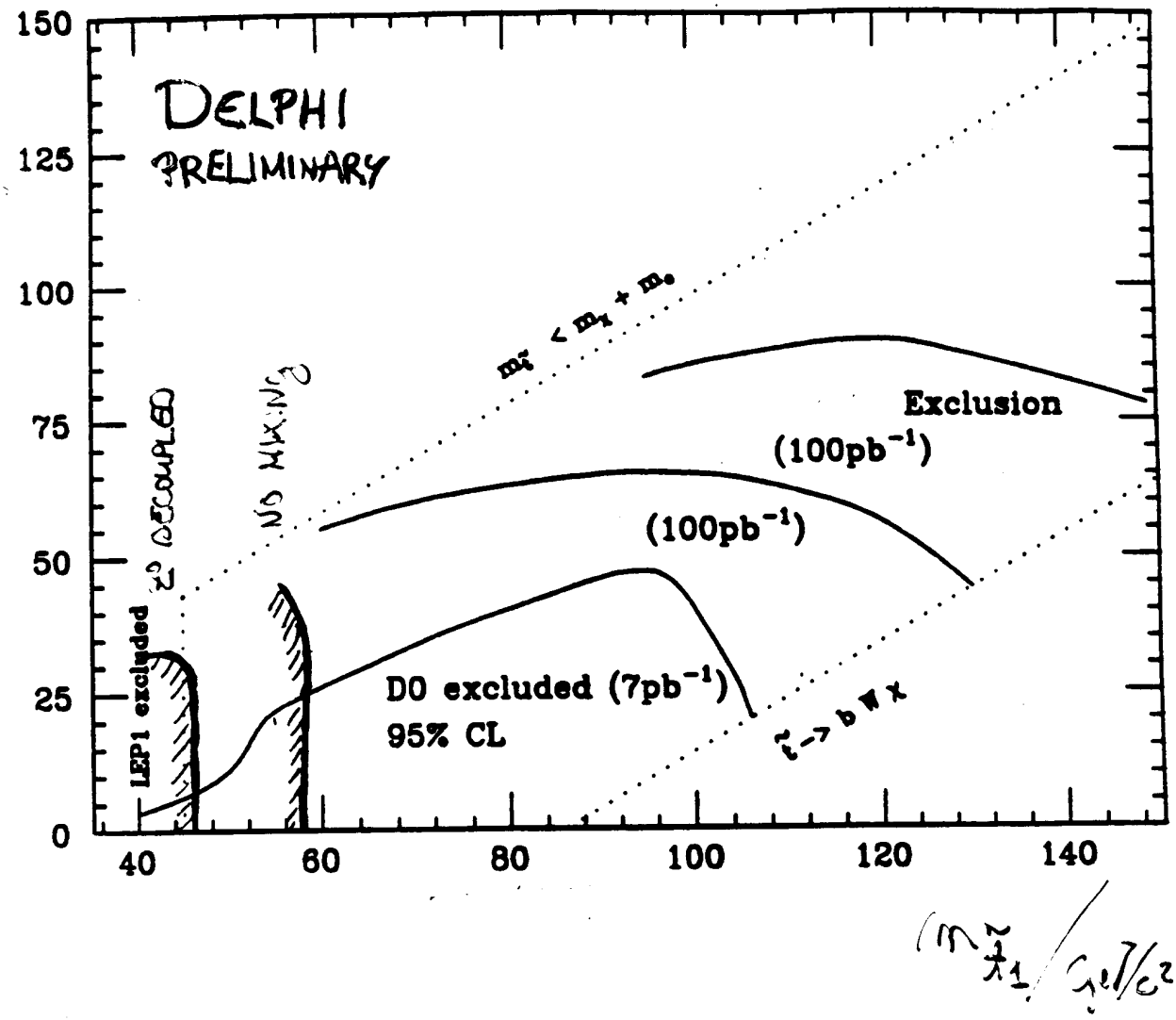
(51,41)

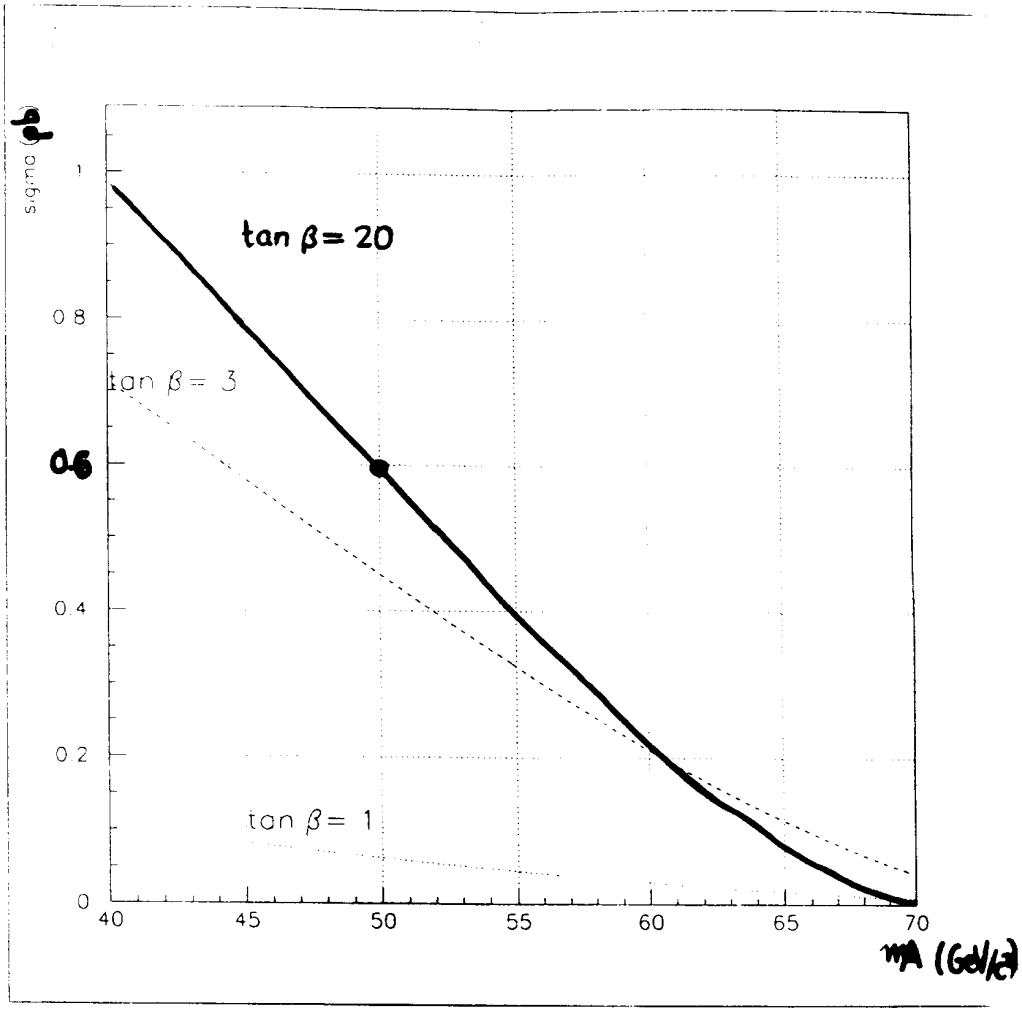


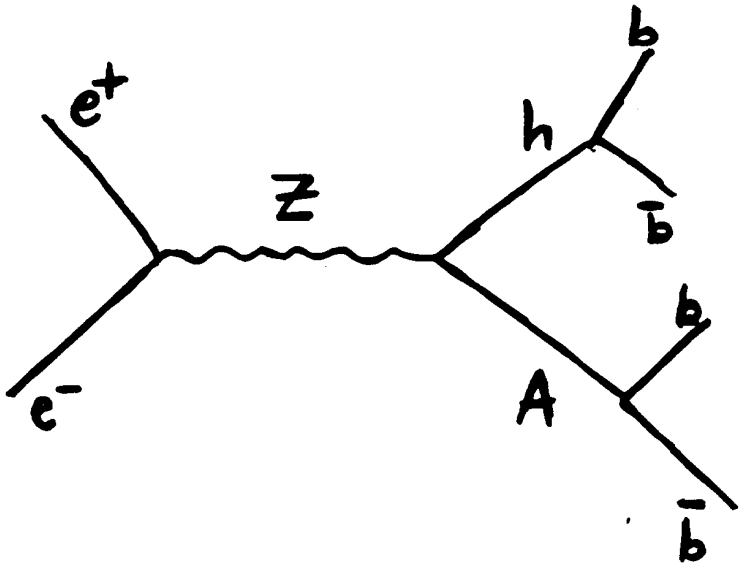
→ % CANDIDATES

$\varepsilon_{(55,35)} = 50\%$

$\varepsilon_{(51,41)} = 37\%$


DELPHI
PRELIMINARY
Exclusion
(100pb^{-1})
(100pb^{-1})
D0 excluded (7pb^{-1})
95% CL
LEP1 excluded
150
125
100
75
50
25
0
40
60
80
100
120
140


sigma/sigma
1
0.8
0.6
0.4
0.2
0
tan β= 20
tan β= 3
tan β= 1
40
45
50
55
60
65
70
mA (GeV/c²)


e+
e−
Z
h
A
b
b̄
b
b̄

Selection of events :

1) Hadronic event; non radiative.

$$|P_{z\,miss_{CH}}| < 10 \text{ GeV}$$

2) $H_2 + H_4 < 1$ (Spherical event)

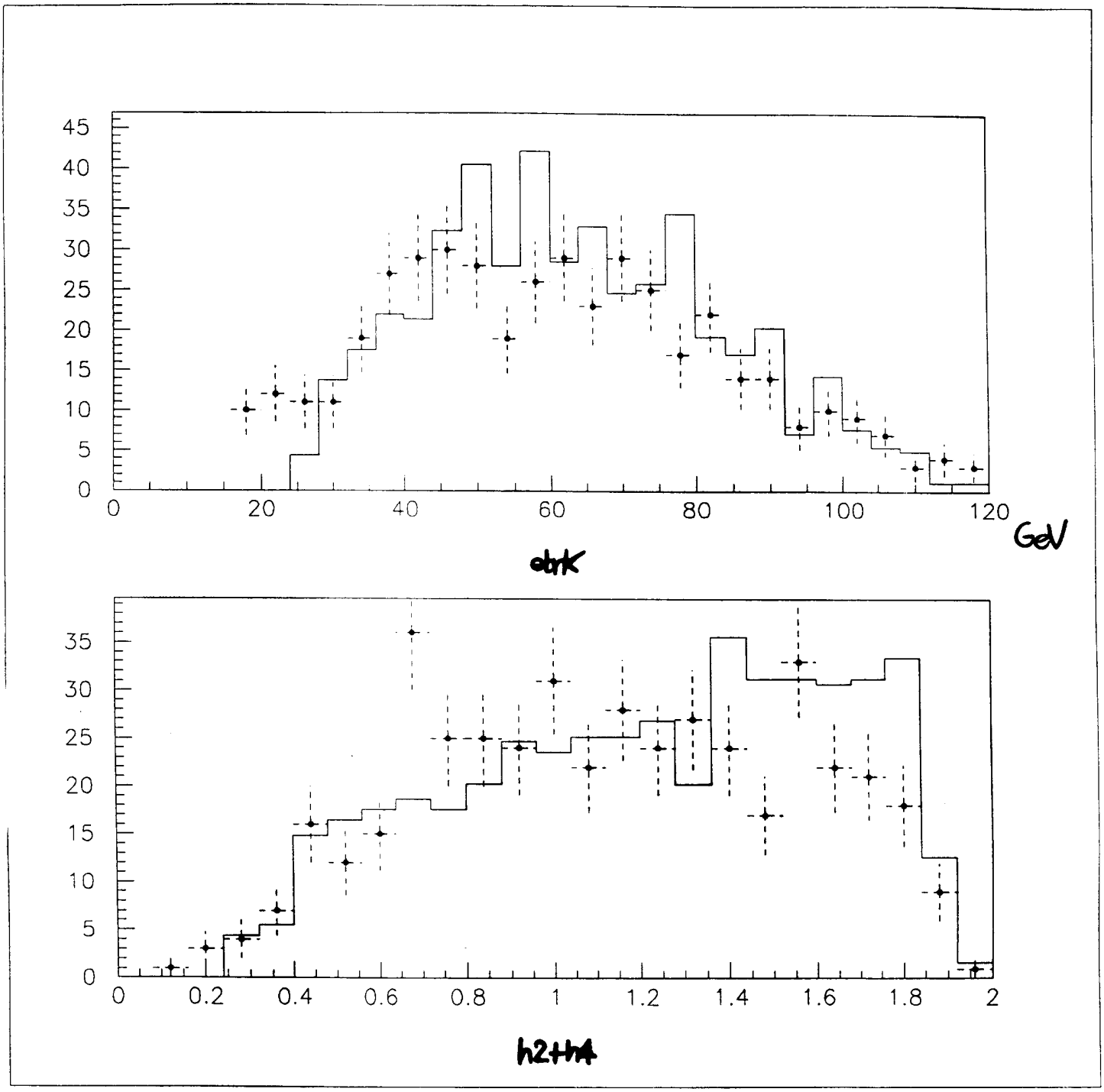
3) $E_{charged} > 50$ GeV

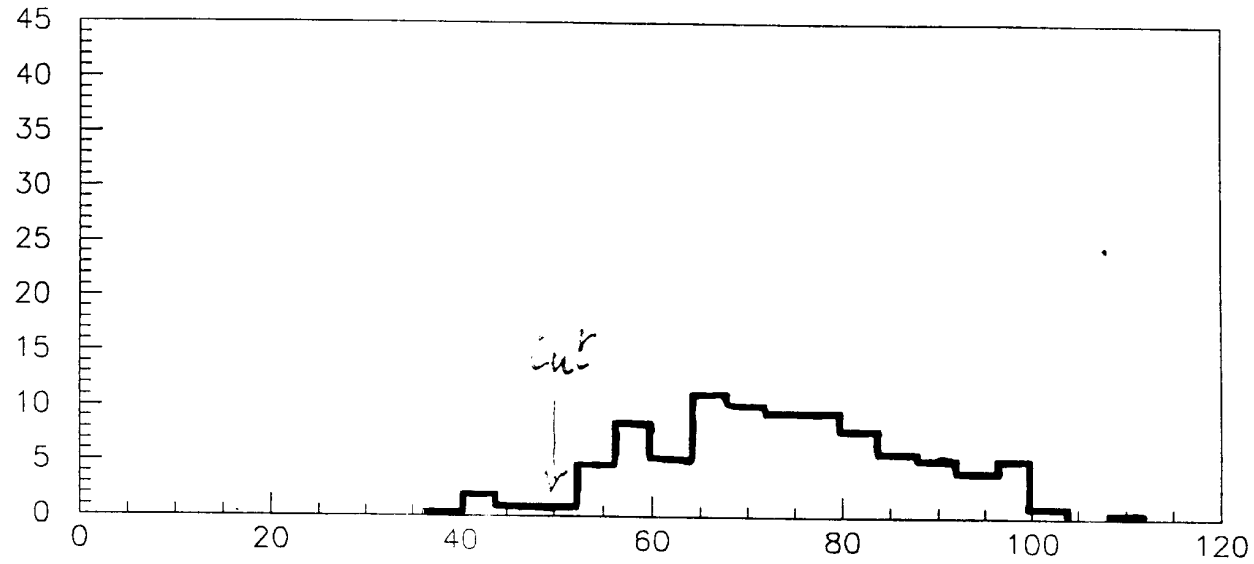
4) # jets ≥ 4 ($y_{min} = 0.01$)

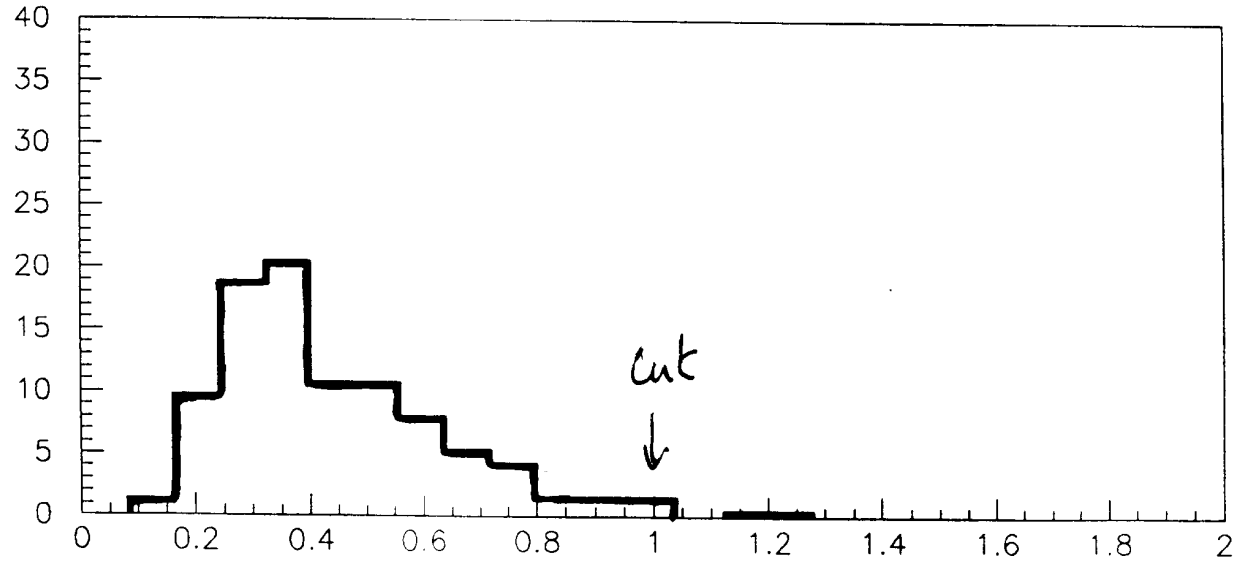
DATA : 55 events

MC : 45 events

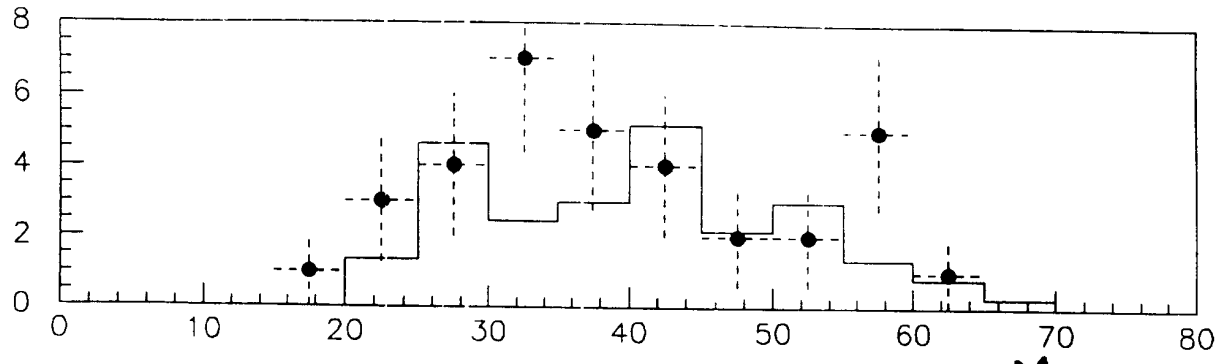
Hadronic, non radictive events.




45
40
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
cut
etrk

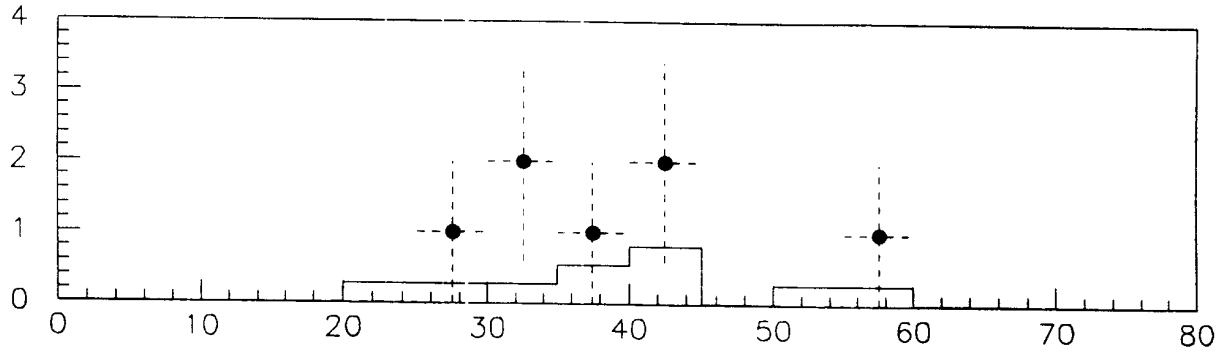

40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
cut
h2+h4

CONSTRAINED mass fit, $m_h = m_H$

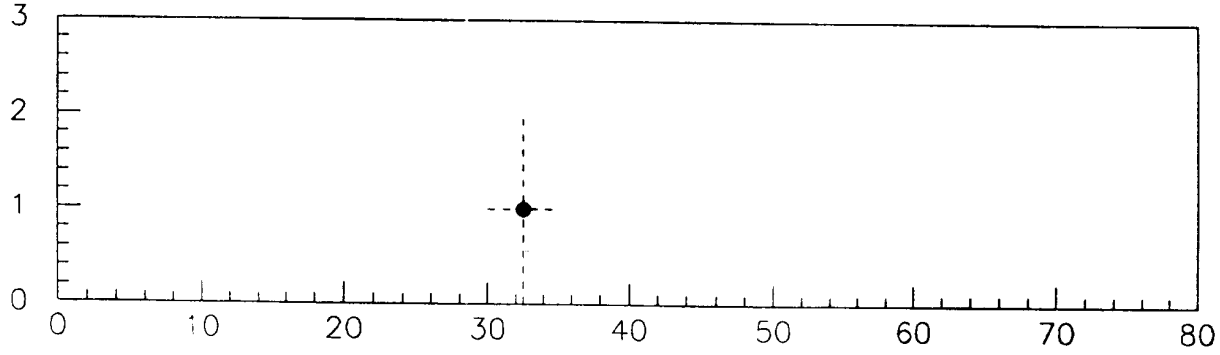


→ Mass

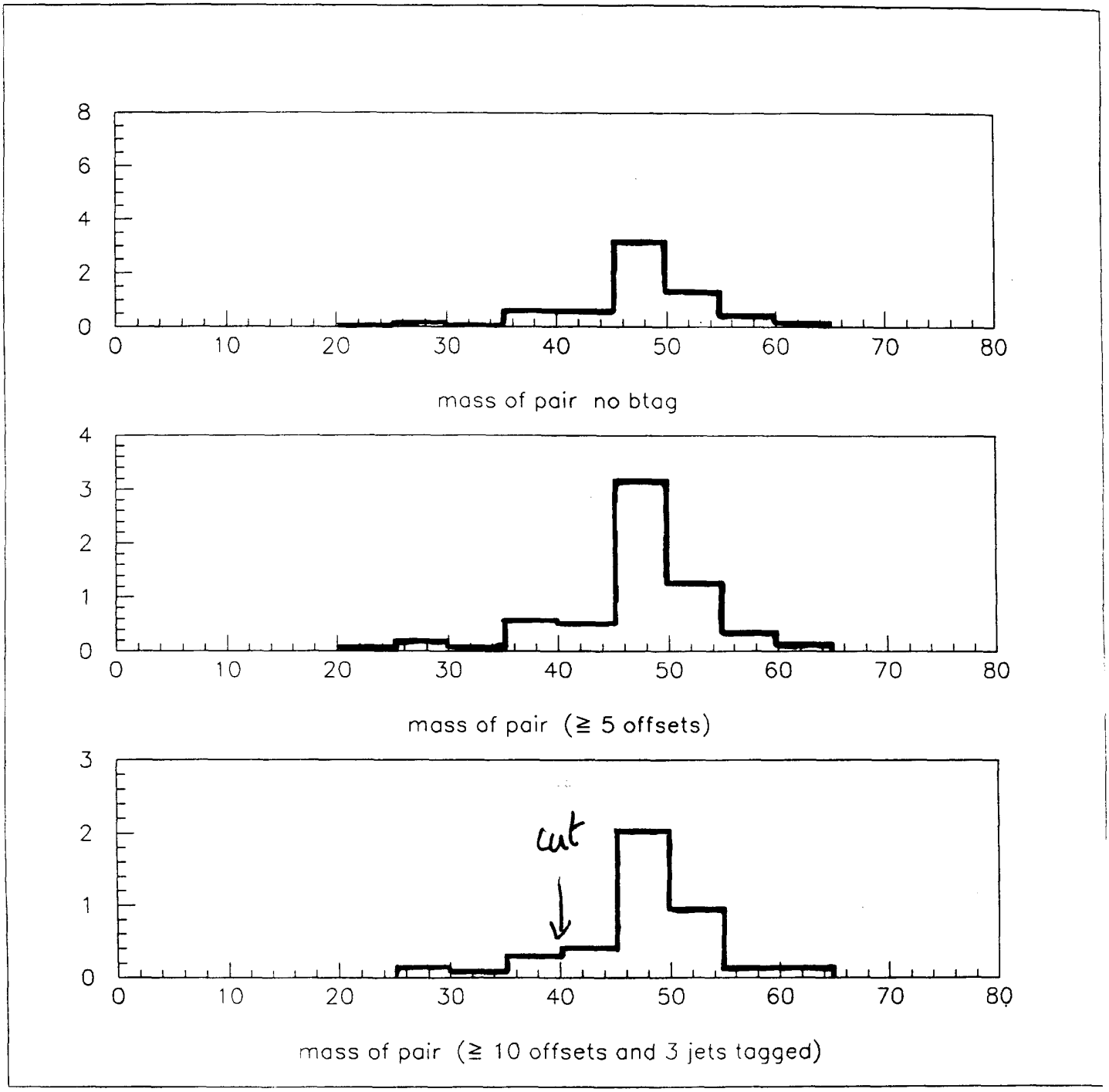
mass of pair no btag



mass of pair (≥ 5 offsets)



mass of pair (≥ 10 offsets and 3 jets tagged)


8
6
4
2
0
0
10
20
30
40
50
60
70
80
mass of pair no btag
4
3
2
1
0
0
10
20
30
40
50
60
70
80
mass of pair (≥ 5 offsets)
3
2
1
0
cut
0
10
20
30
40
50
60
70
80
mass of pair (≥ 10 offsets and 3 jets tagged)

5) b-tagging

A) Loose :

# of jets ≥ 5 $\longrightarrow$ DATA : 9 events
MC : 8.5 "
Signal : 75 %

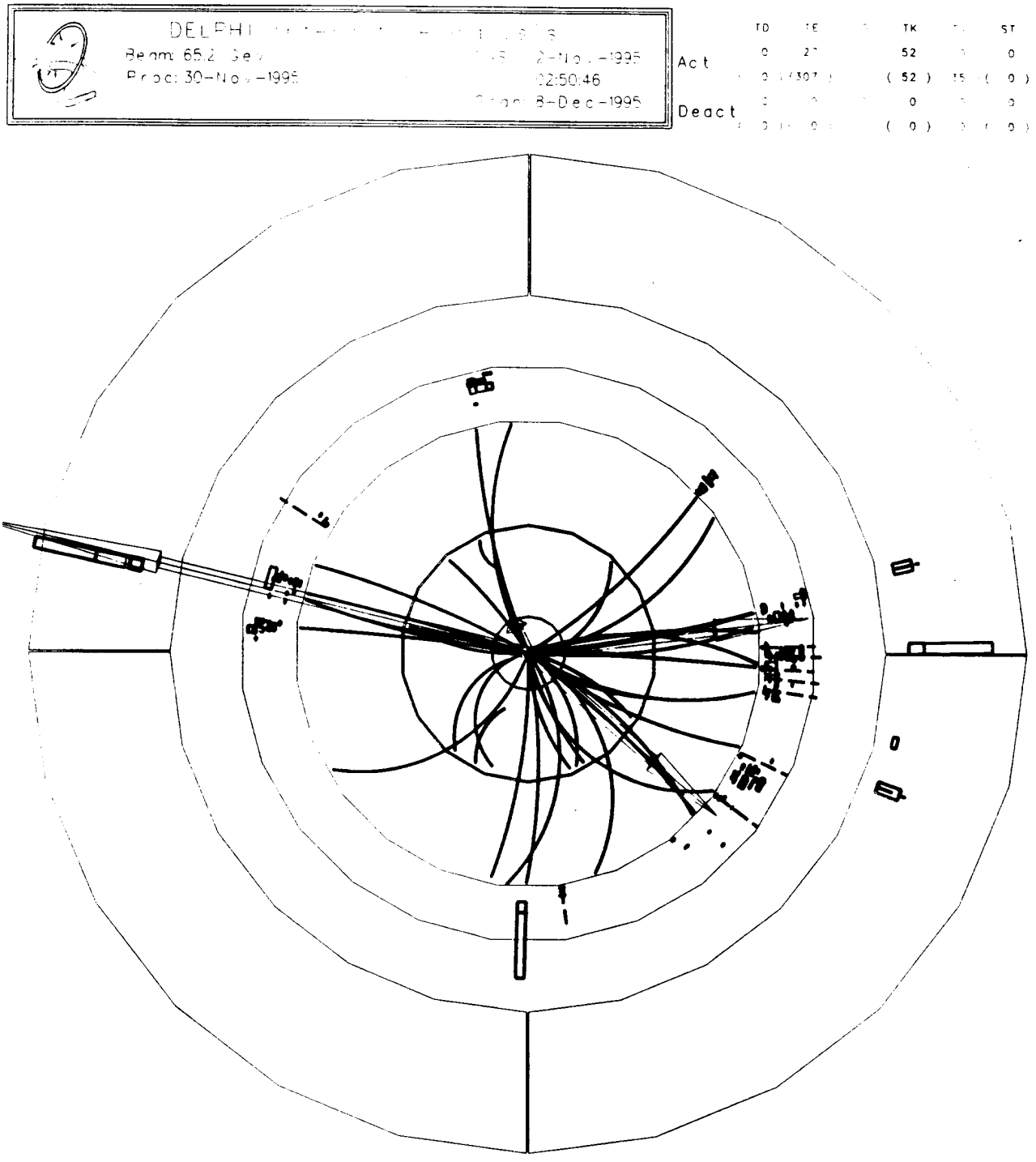
B) tight

# of jets ≥ 10 & ip3+ip4 ≥ 2

At least 3 jets tagged DATA : 2
MC : 0.2
Signal : 38 %

6) Kinematical fit.

Constrained to equal pair masses (Kjaer
(discard bad χ^2 events)


DELPHI
Beam 65.2 GeV
Proc: 30-Nov-1995
2-Nov-1995
02:50:46
8-Dec-1995
TD TE TK ST
Act 0 27 52 0
(52) (0)
Deact 0 0 0
(0) (0)

Finally:

Choose interesting mass region:

$AMXX \geq 40$ GeV/c²

Results:

DATA: 0 events

MC ≃ 0 events

SIGNAL: 34 % ε

95% CL exclusion: 1.47 pb

(no improvement with respect to LEPI)

Combined LEP: 0.37 pb

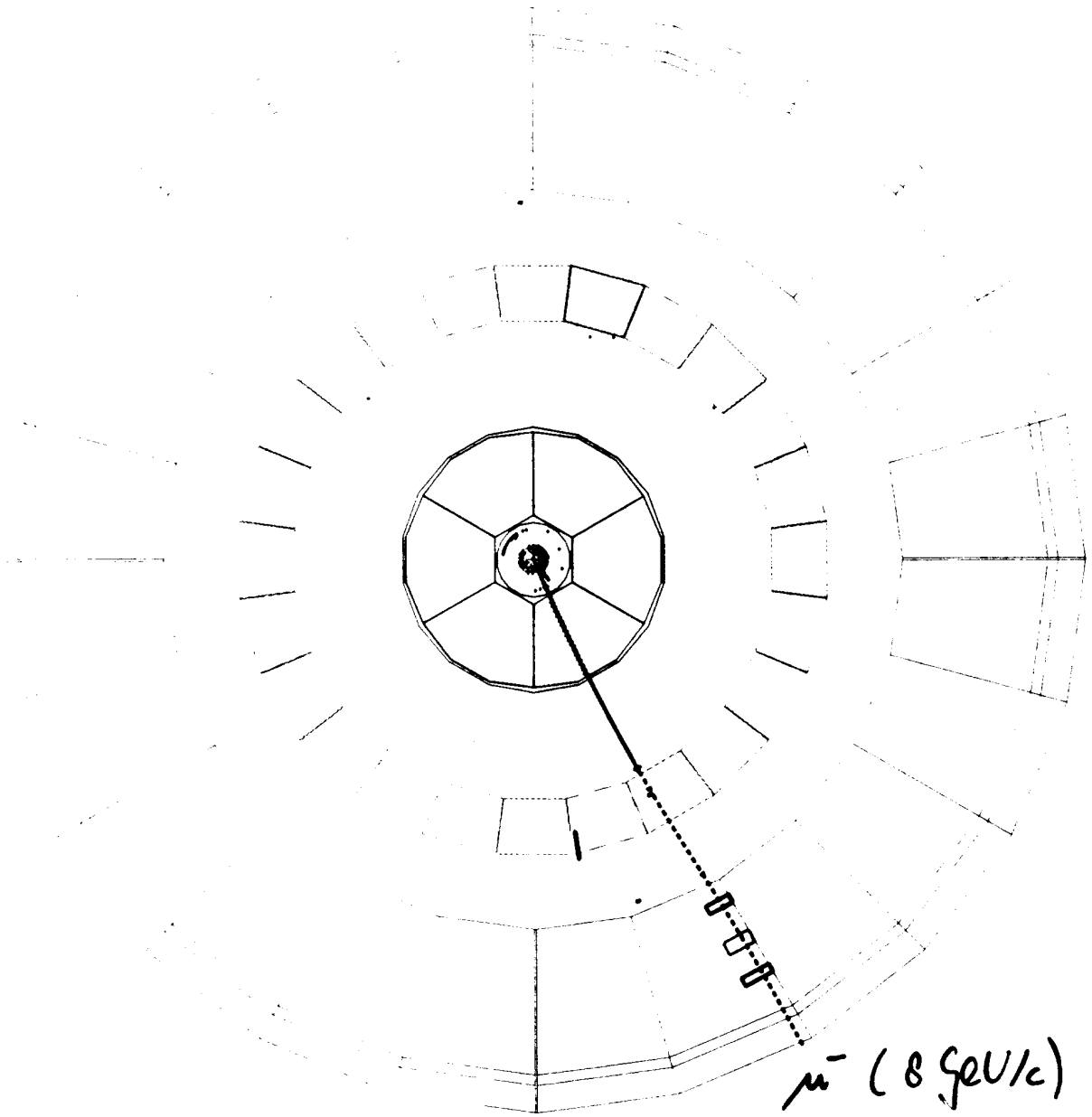
(Limit: $mA \geq 55$ GeV/c², high $tg\beta$)

$\gamma e \to \ell \tilde{\chi}_1^-$, CR single track search
$\hookrightarrow e \tilde{\chi}_1^0$

1 candidate: $p_\mu = 8.0$ GeV

DELPHI Interactive Analysis
Beam: 68.1 GeV
Proc: 4-Dec-1995
DAS: 17-Nov-1995 12:09:29
Scan: 8-Dec-1995

	TD	TK	ST
Act	99	1	0
	(101)	(1)	(0)
Deact	0	0	0
	(0)	(1)	(0)



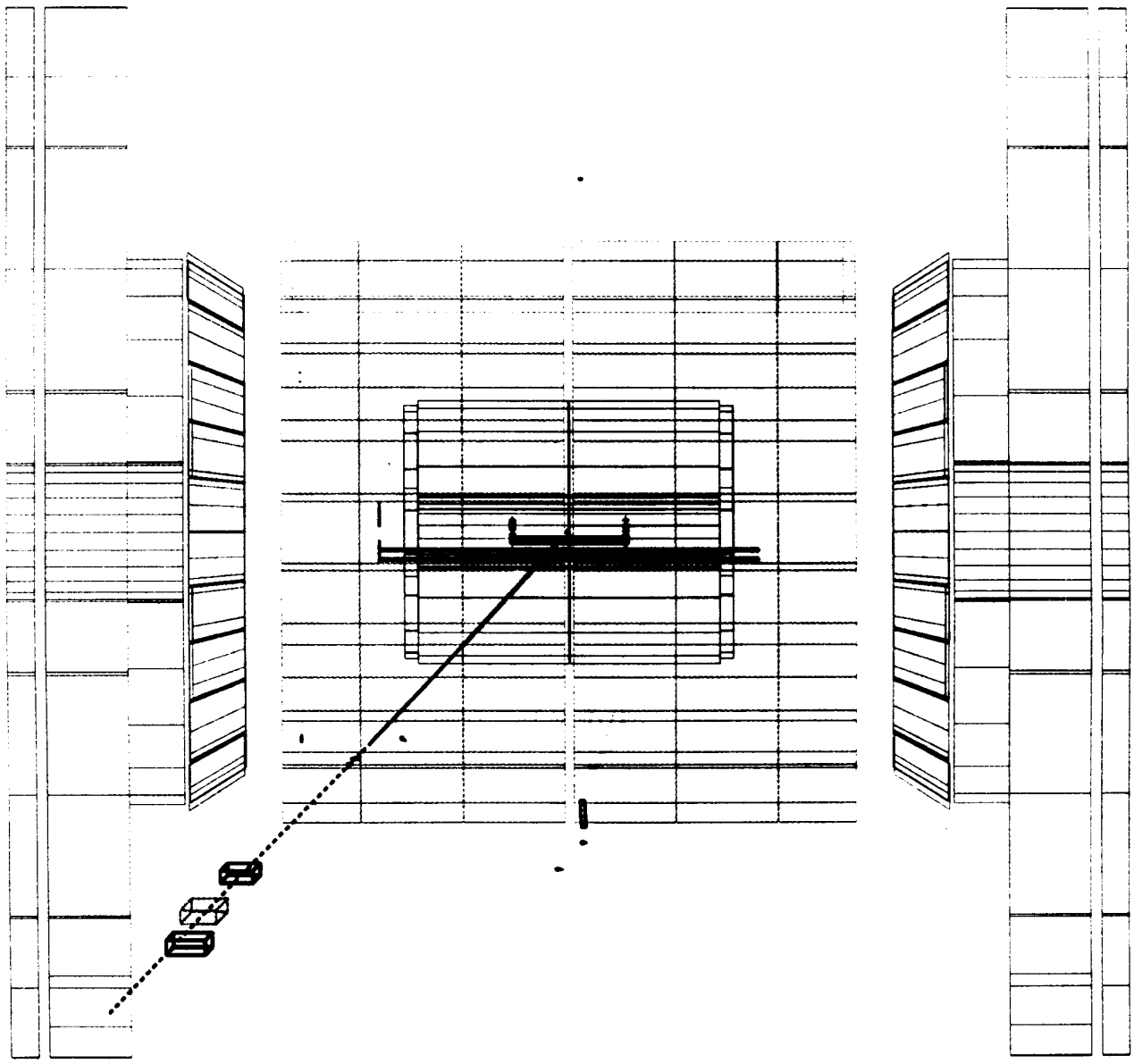
DELPHI Interactive Analysis

Beam: 68.1 GeV — DAS: 17-Nov-1995

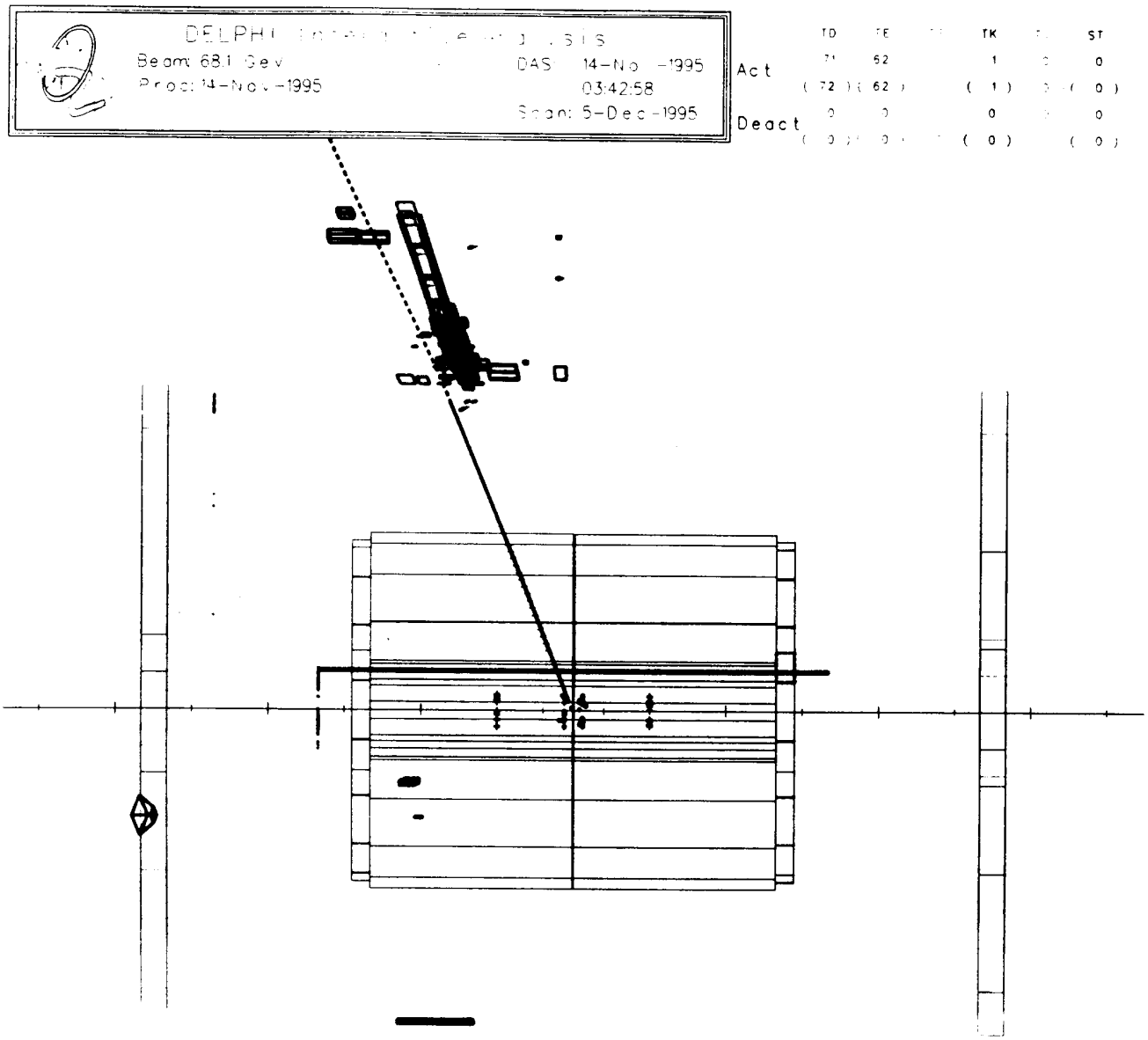
Prod: 4-Dec-1995 — 12:09:29

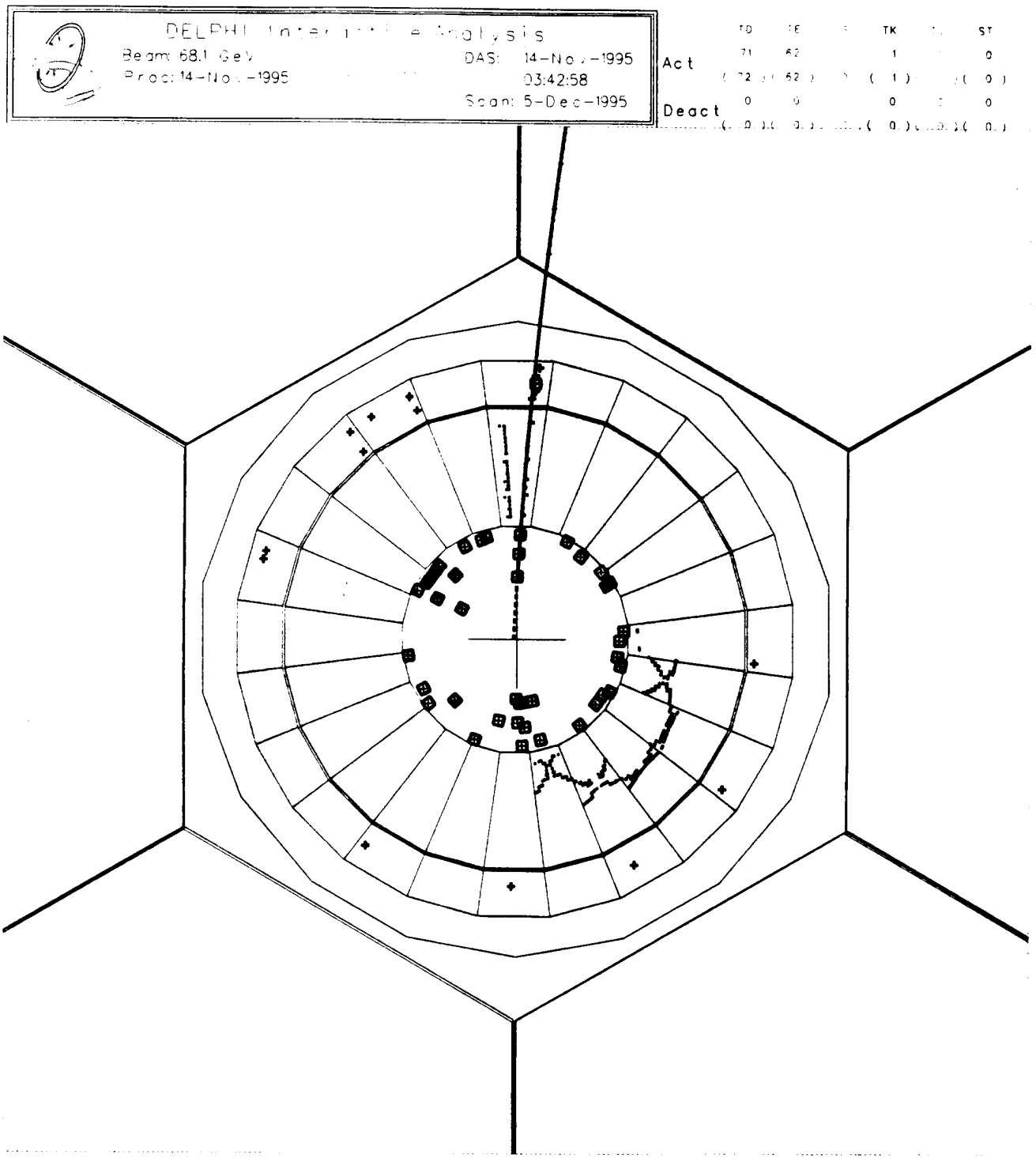
Reco: 8-Dec-1995

	TD	TK	ST
Act	99	1	0
	(101)	(1)	(0)
Deact	0	0	0
	(0)	(1)	(0)



$1\pi + 1\gamma : \Sigma E = 69$ GeV

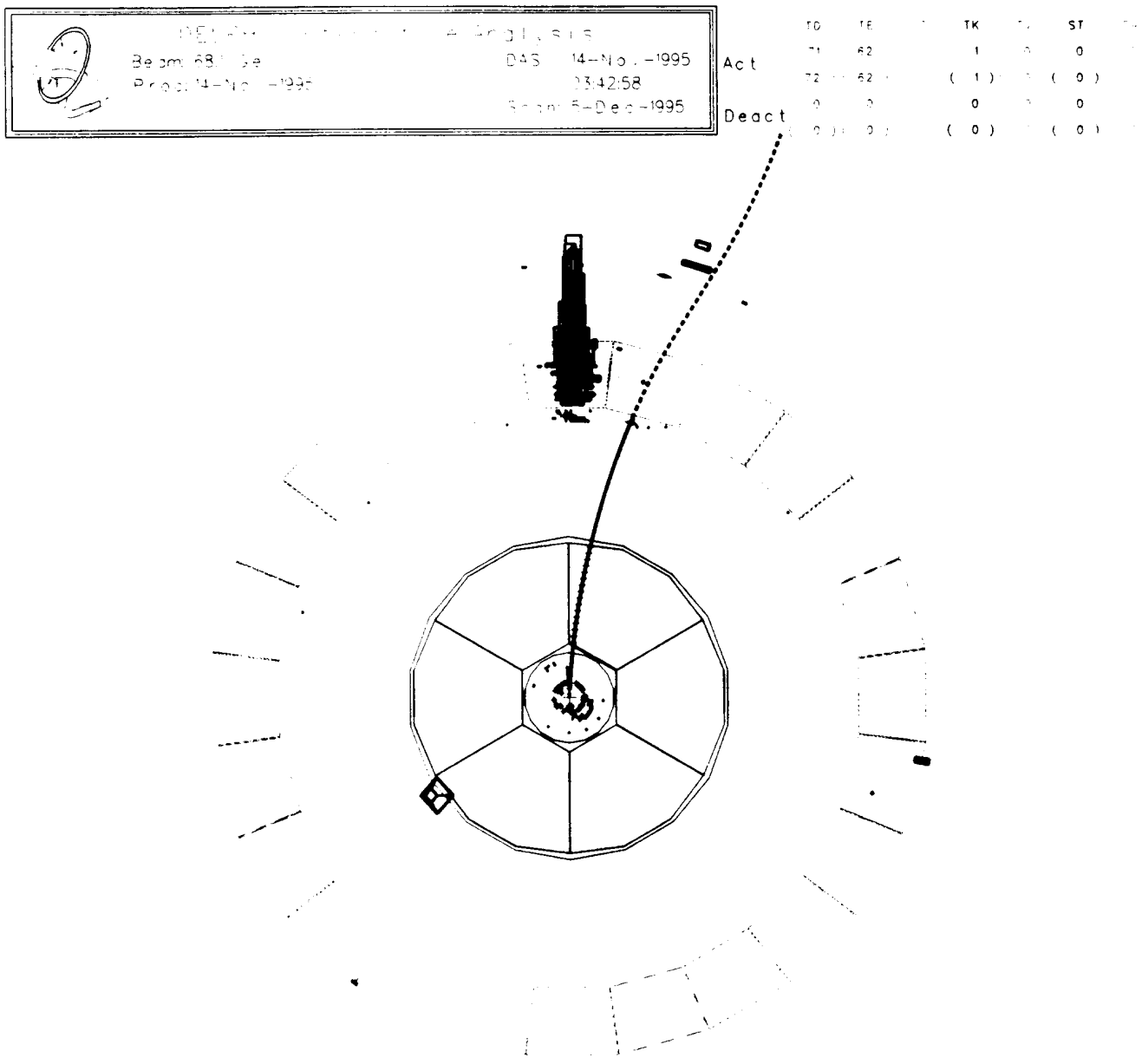



DELPHI
Beam: 68.1 GeV
Proc: 14-Nov-1995
DAS: 14-Nov-1995
03:42:58
Scan: 5-Dec-1995
TD TE TK ST
Act 71 62 1 0
Deact 0 0 0 0

$e^+e^- \to \tau\tau$

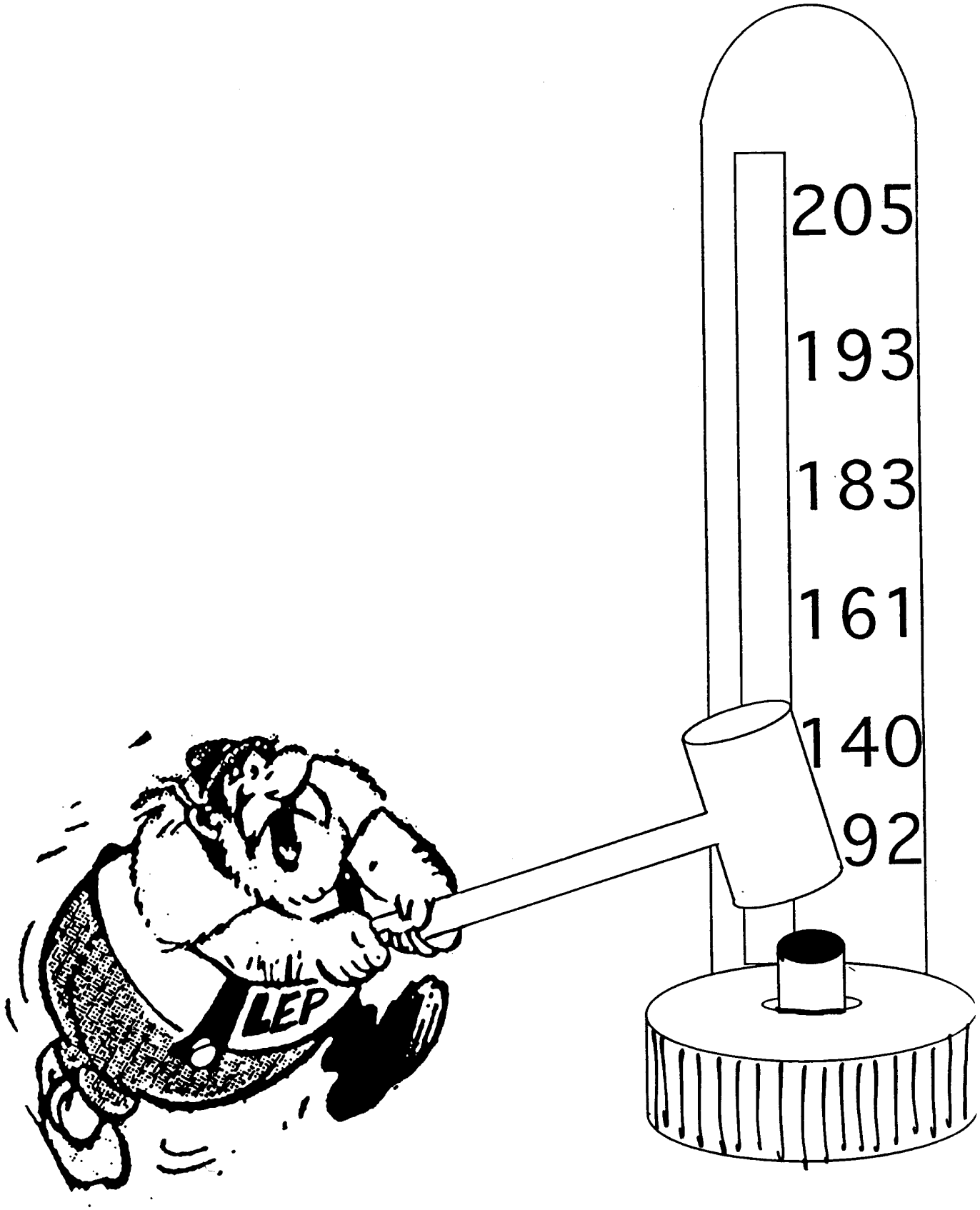
$\tau \to \nu_\tau \pi^0$

$\tau \to \nu\pi$



SUMMARY

YES
WE
HAVE
NO
ANOMALIES

YET, AT LEAST AT $\sqrt{s} \lesssim 140$ GeV

DELPHI