Gluon Splitting into $b\bar{b}$

Toshinori Abe

6/23/2000

@ Kirkwood SLD meeting.

What's New ?

- Recon 17 data.

  (Previous Result used Recon 15)

  ⇒ expect better b-tag performance.

- 50k $g \to b\bar{b}$ MC

  ⇒ allow more detailed MC study.

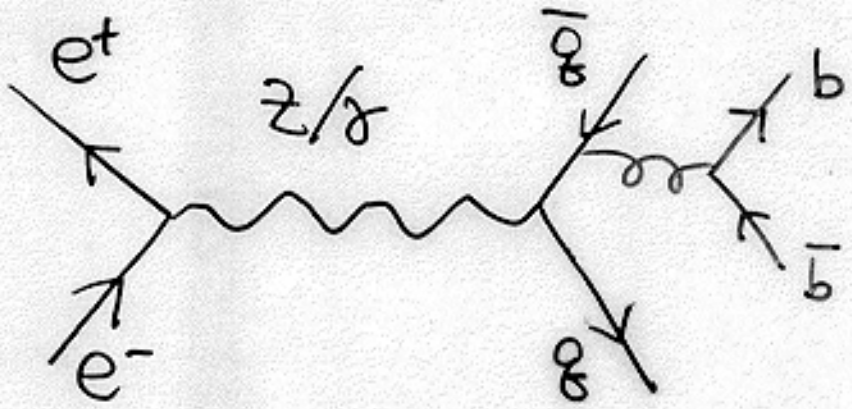
- ZVTOP3 (ghost track method)

  + Neural Network technique

  ⇒ better $g \to b\bar{b}$ tagging and

  improved S/N.

$g \to b\bar{b}$ event.



Main Systematic Source of R_b

- Small Cross Section

$$\frac{\#\text{ of } g \to b\bar{b} \text{ events}}{\#\text{ of } Z^0 \to q\bar{q} \text{ events}} \sim 0.2\%$$

- Huge Background ($Z^0 \to b\bar{b}$)

$$\sigma(Z^0 \to b\bar{b}) \gg \sigma(g \to b\bar{b})$$

We measured $g \to b\bar{b}$ process

$$g_{b\bar{b}} = (3.07 \pm 0.71 \pm 0.66) \times 10^{-3}$$

(Preliminary @ 99 winter).

But.

- Huge systematic error from MC stat. (~ 0.44)

  $\Rightarrow$ need more MC (now 50k $g \to b\bar{b}$ MC).

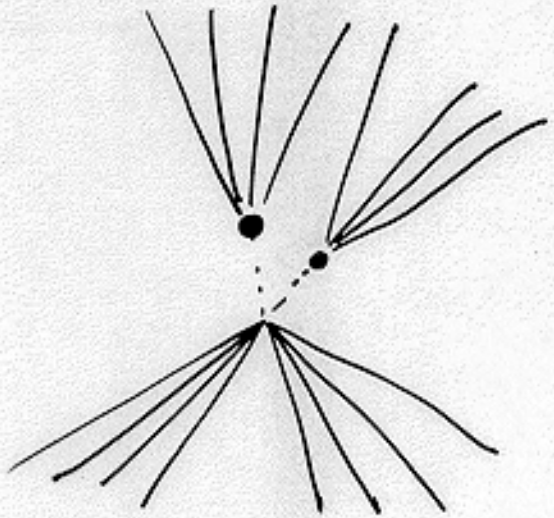
- New B tag routine (ZVTOP3).

- R17

Event Selection.

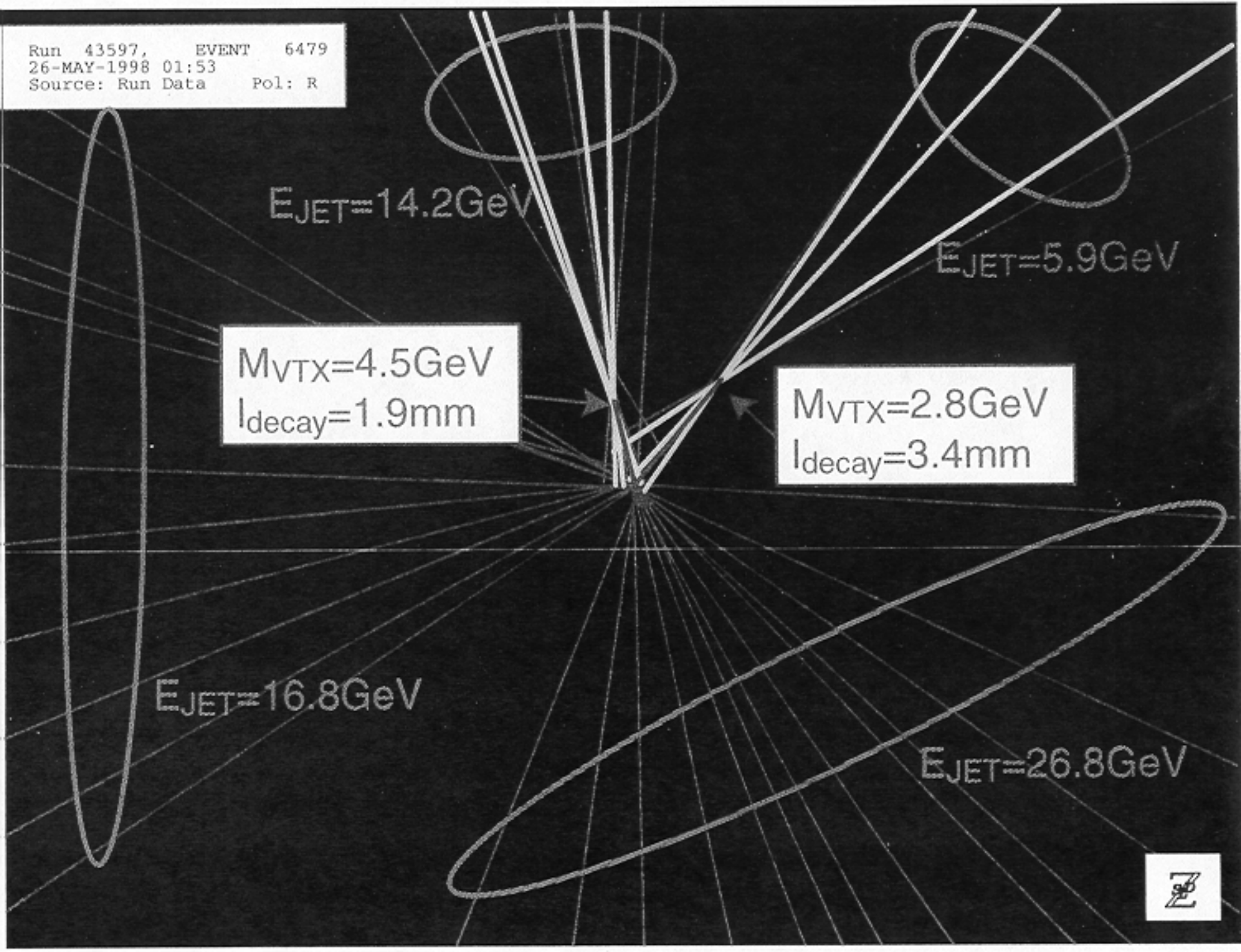
1. 4 jet.

   Track DURHAM $y_{cut} = 0.009$.

2. 

   Secondary Vertex in smallest angle jet combination.

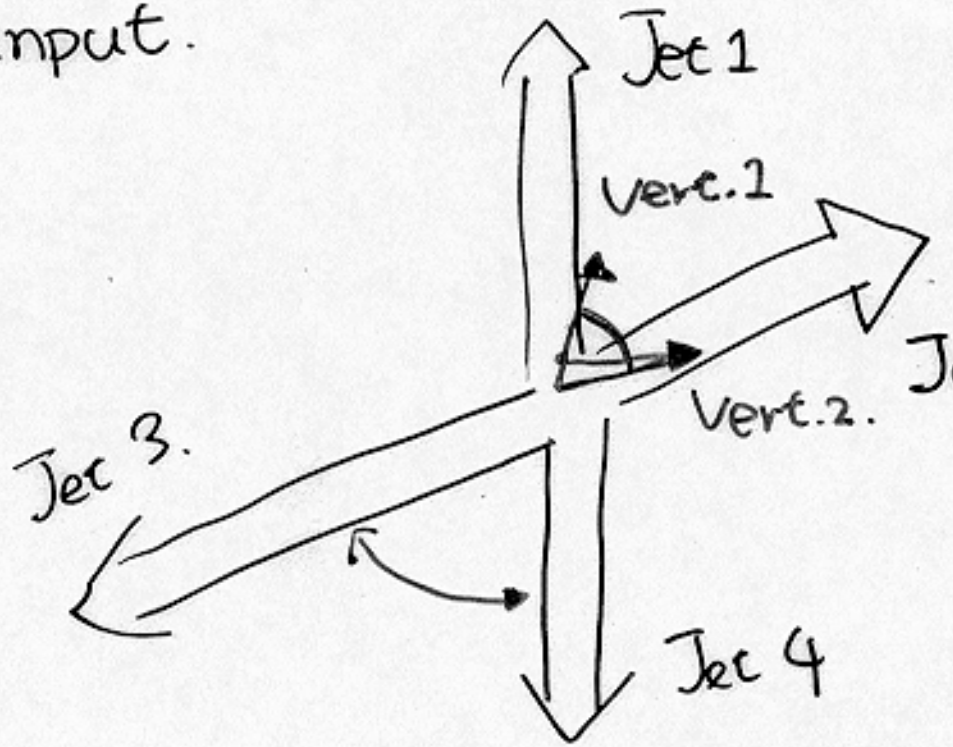
	ZVTOP	ZVTOP3
ε	7.3%	9.7%
S/N	20.9%	18.3%


Run 43597, EVENT 6479
26-MAY-1998 01:53
Source: Run Data Pol: R
E_JET=14.2GeV
E_JET=5.9GeV
M_VTX=4.5GeV
l_decay=1.9mm
M_VTX=2.8GeV
l_decay=3.4mm
E_JET=16.8GeV
E_JET=26.8GeV

3. Topological Event Selection

⇒ Use Neural Network !

Input.

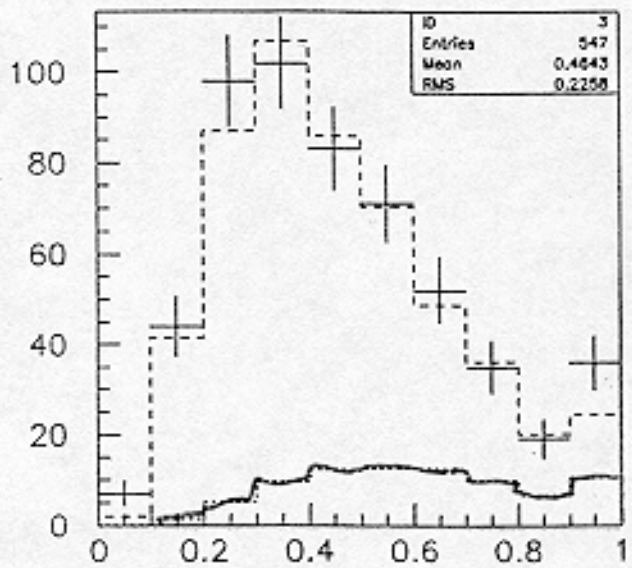


Use R16 MC for NN training.

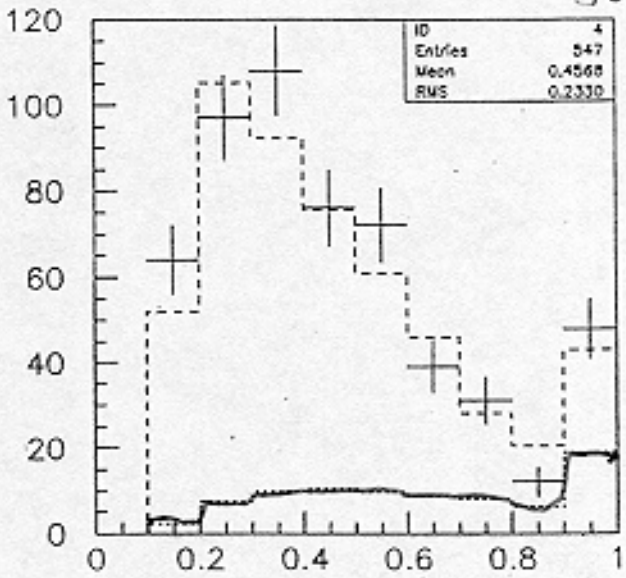
① Vertex Mass 1
② Vertex Mass 2.
③ angle between 2 vertics.
④ angle between Jets
⑤ 15 Mvtx - Rvtx 1
⑥ " 2.
⑦ Ejet 1+2
⑧ Ejet 3+4
⑨ $\cos \alpha_{1234}$.

+ : data

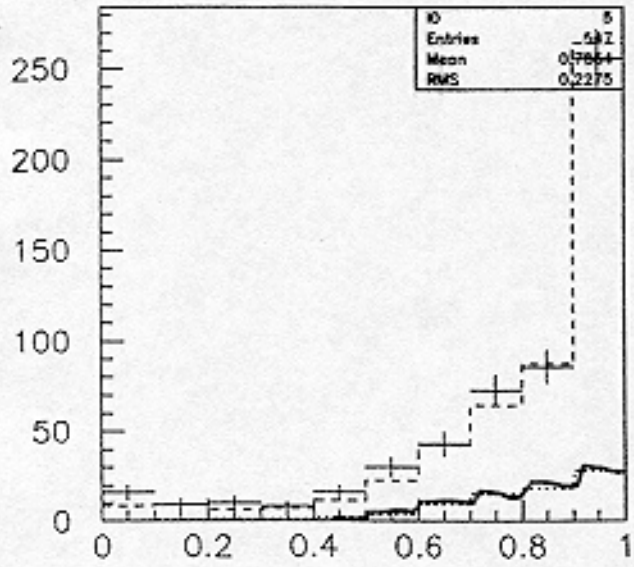
⊓ : MC ⊓ : $g \to b\bar{b}$ (MC)



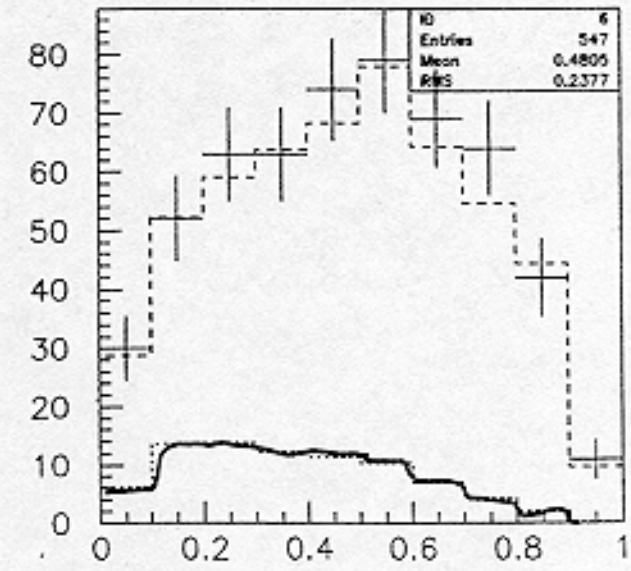
MAX M_{PT} (VRT) data



MIN M_{PT} (VRT) data

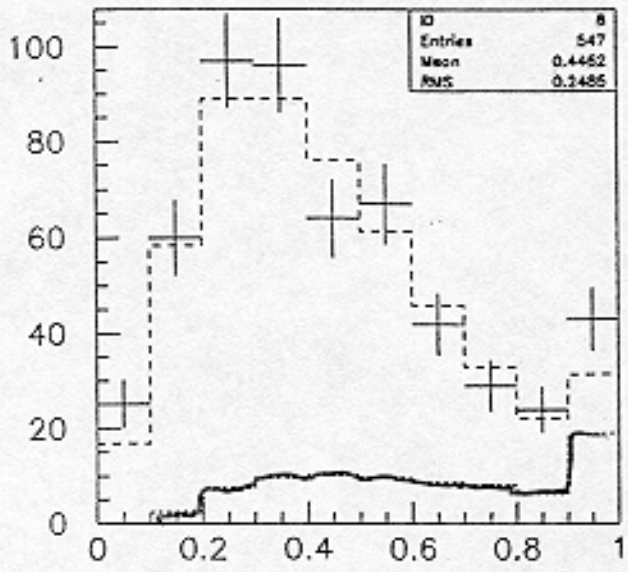


$\cos\vartheta_{12}$ data

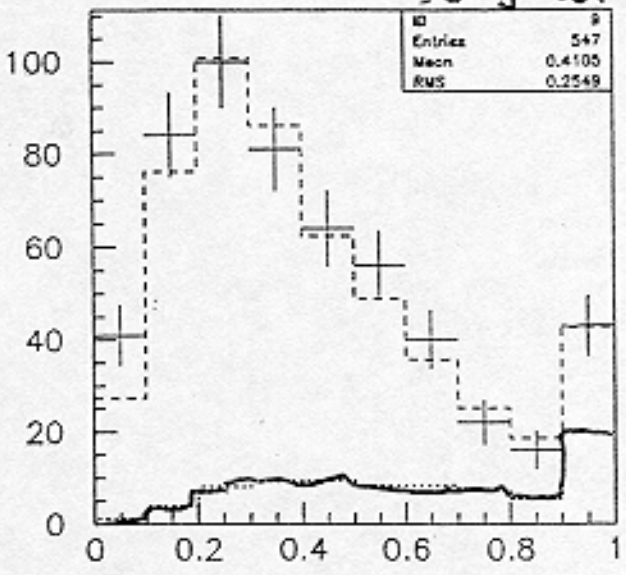


$\cos\vartheta_{34}$ data

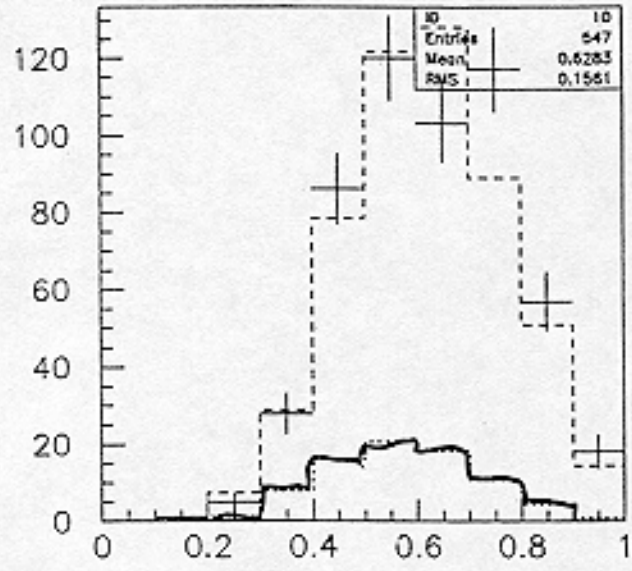
† : data
Ω : MC
Ω : $g \to b\bar{b}$(MC)



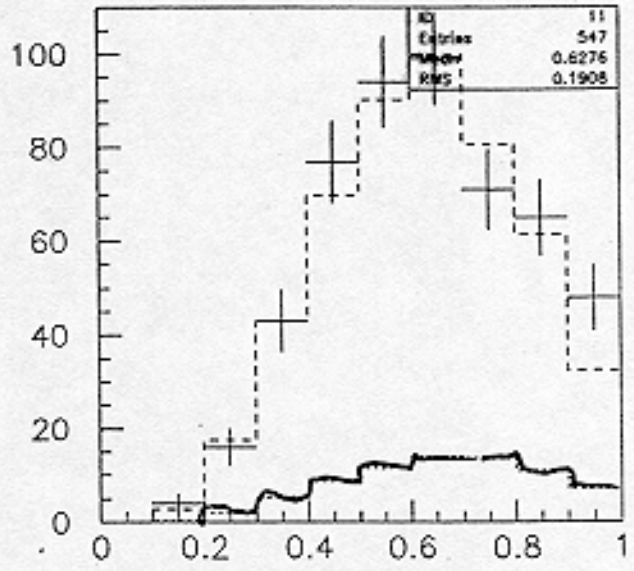
15Mvtx−Pvtx MAXdata



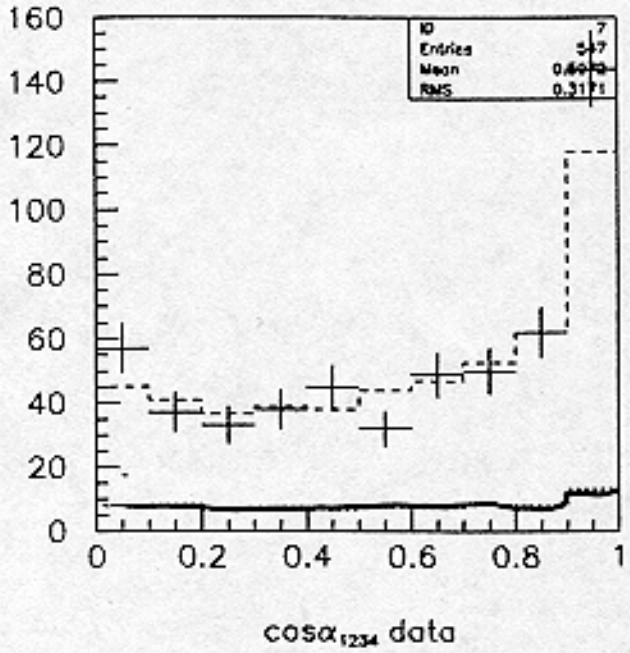
15Mvtx−Pvtx MINdata

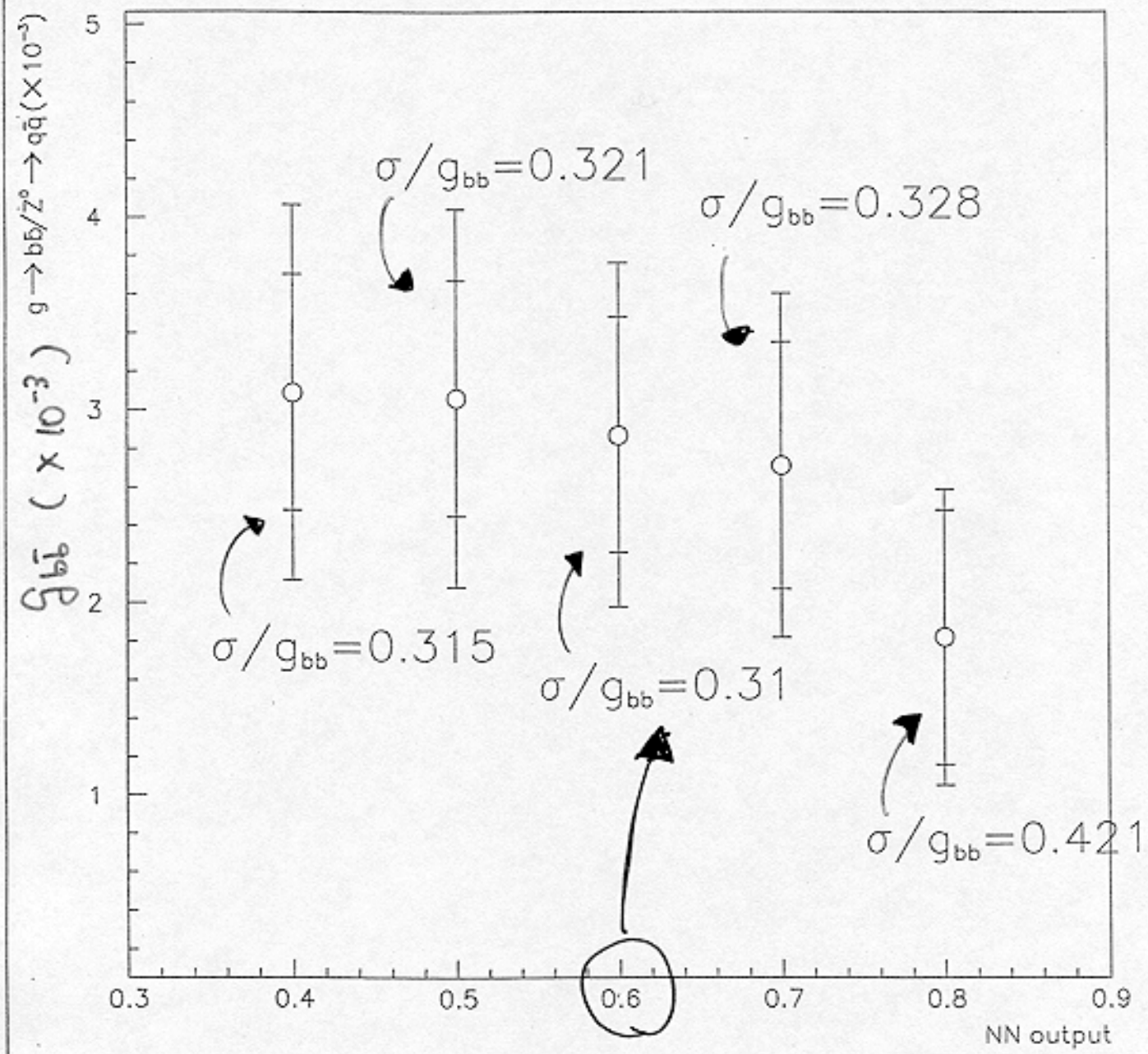


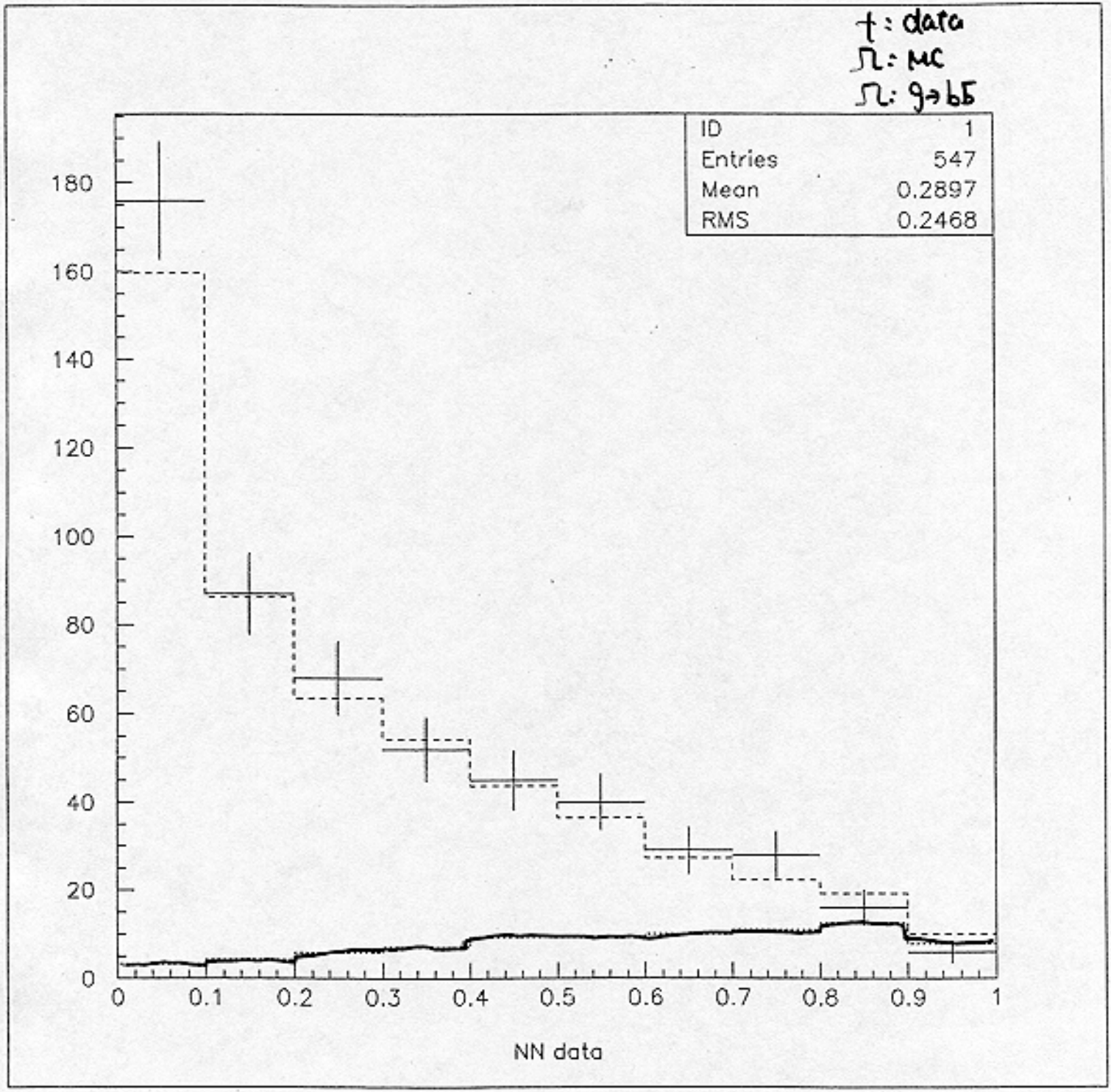
E_{JET12} data



E_{JET34} data


160
140
120
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
ID
Entries
Mean
RMS
cosα1234 data


$\sigma/g_{bb}=0.321$
$\sigma/g_{bb}=0.328$
$\sigma/g_{bb}=0.315$
$\sigma/g_{bb}=0.31$
$\sigma/g_{bb}=0.421$
$\sigma(e^+e^- \to Z/\gamma^* \to q\bar{q}) \times 10^{-3}$ (pb)
NN output
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2
3
4
5


t : data
MC
g→bb
ID 1
Entries 547
Mean 0.2897
RMS 0.2468
180
160
140
120
100
80
60
40
20
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
NN data

After NN = 0.6 cut.

		old.
$\varepsilon_{g\to b\bar{b}}$ =	4.99 %	(3.86)
$\varepsilon_{g\to c\bar{c}}$ =	0.17 %	(0.10)
ε_{other} =	0.008 %	(0.007)

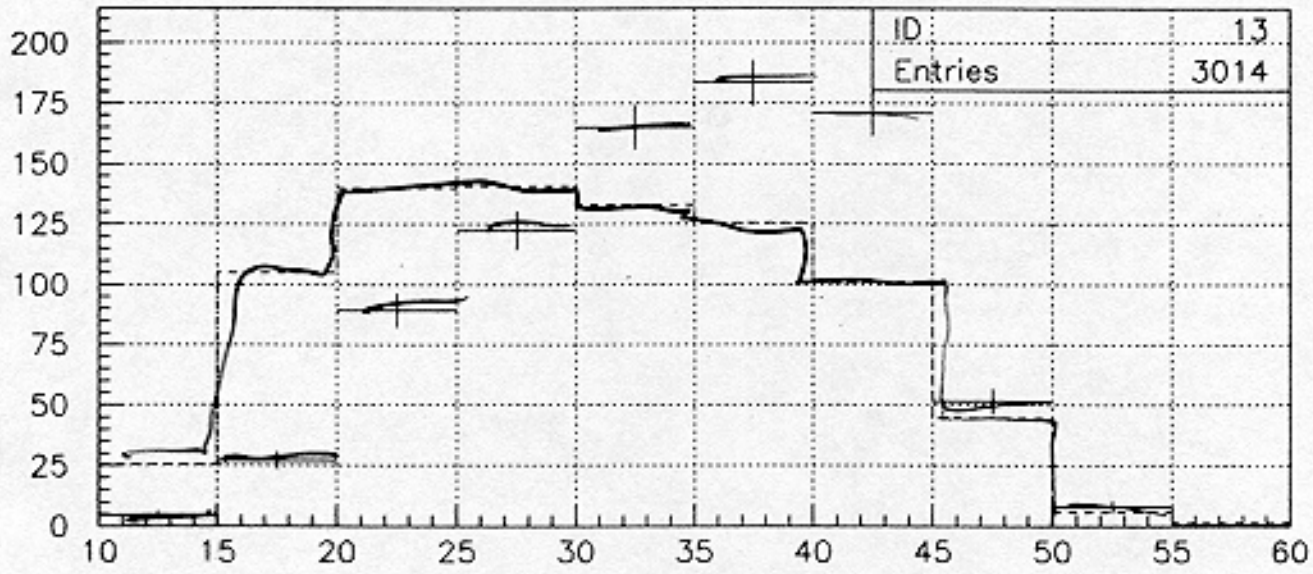
# of selected events =		79	(62)
$(g\to c\bar{c})$	$g_{c\bar{c}} = 3.04\%$	15.2	(7.5) ← $g_{c\bar{c}} \simeq 2.4\%$?
$(Z\to q\bar{q}$ mainly $b\bar{b})$		22.2	(20.1)
$g\to b\bar{b}$		41.6	(34.4)

Π = 52.6 % (55.4%)

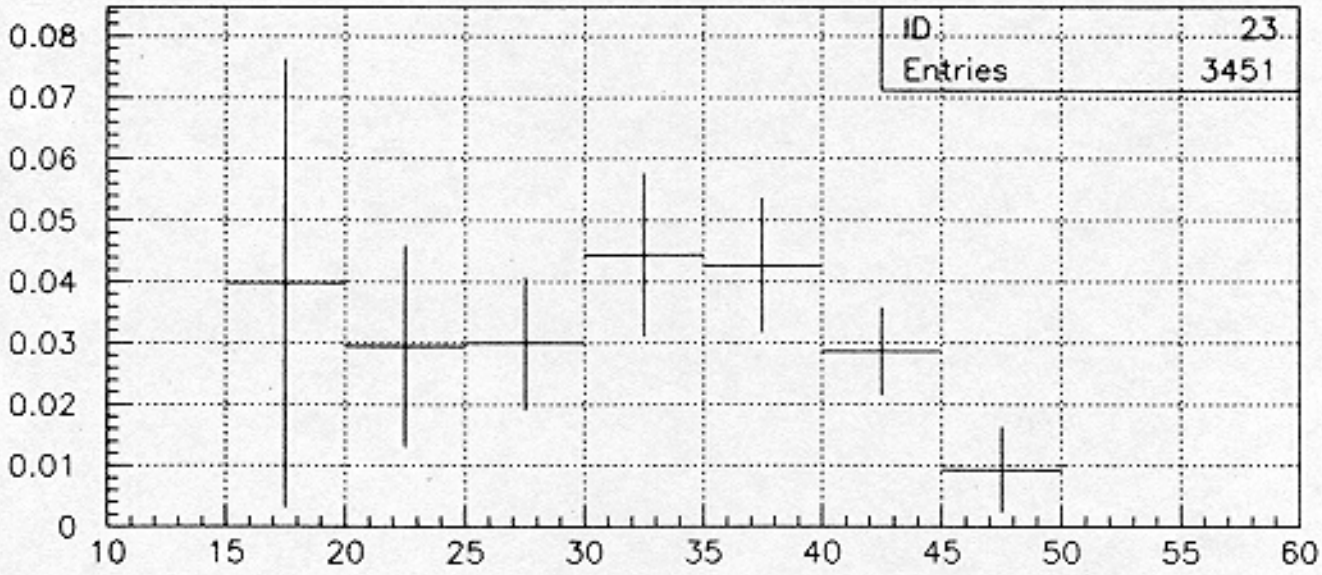
Source	$\Delta g_{b\bar{b}}$ (10^{-3})	new
Monte Carlo statistics	± 0.44	0.14
B hadron lifetimes	± 0.01	0.02
B hadron production	± 0.07	0.02
B hadron fragmentation	± 0.12	0.13
B hadron charged multiplicities	± 0.11	0.03
D hadron lifetimes	± 0.01	0.01
D hadron production	± 0.03	0.01
D hadron charged multiplicities	± 0.08	0.02
Energy distribution of $g \to b\bar{b}$	± 0.08	0.56 !
b quark mass	± 0.06	0.10
$g_{c\bar{c}}$	± 0.09	0.13
4-jet rate discrepancy	± 0.14	0.09
IP resolution	± 0.09	→ gone
Track resolution	± 0.26	→ gone
Tracking efficiency	± 0.29	0.17
Total (Preliminary)	± 0.66	0.65

Table 2: Systematic uncertainties on $g_{b\bar{b}}$.

$B \to D\bar{D}+X$ I15 fraction 0.07

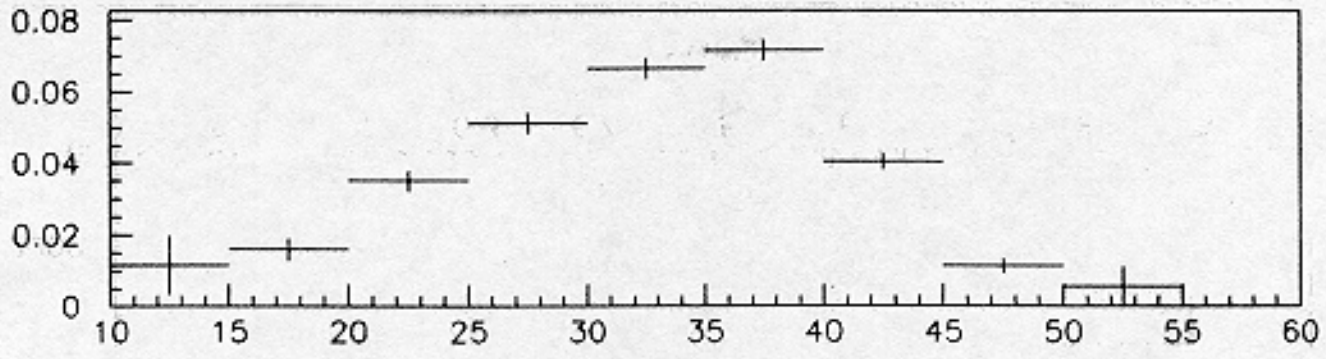


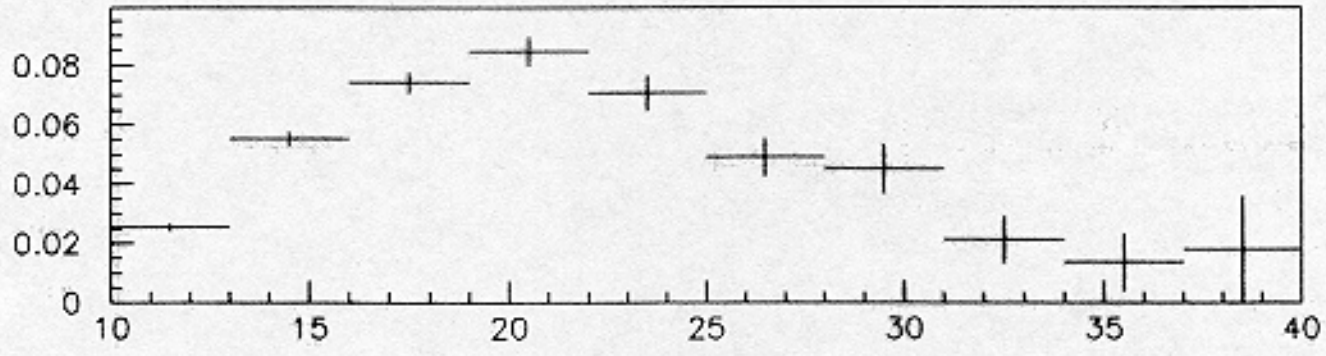
E_{gbb} $Z^0 \rightarrow q\bar{q}+g : g \rightarrow b\bar{b}$ event

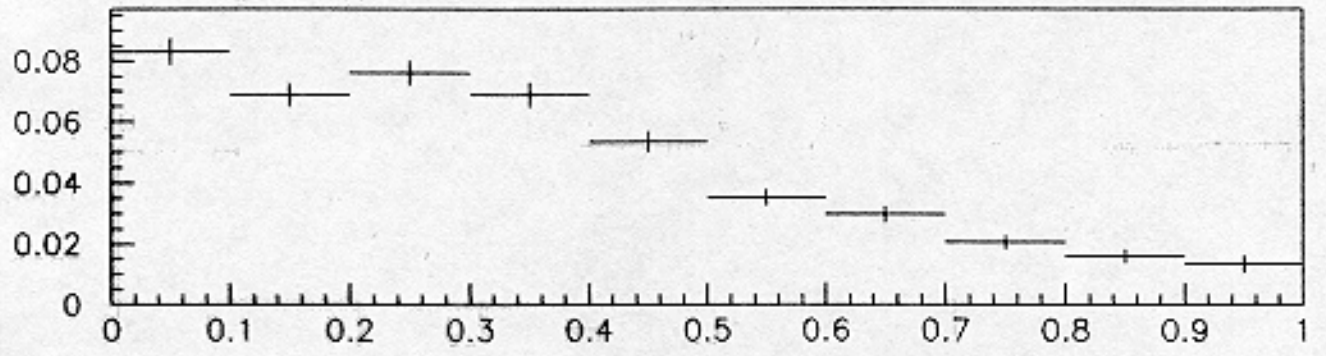


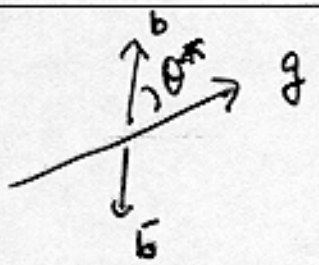
E_{gbb} $Z^0 \rightarrow uds+c+b+g \rightarrow c\bar{c}+g \rightarrow b\bar{b}$ event

$E_{g \rightarrow b\bar{b}}$


0.08
0.06
0.04
0.02
0
10 15 20 25 30 35 40 45 50 55 60
$E_{g\bar{b}b}$
$E_{g\to b\bar{b}}$ (GeV)

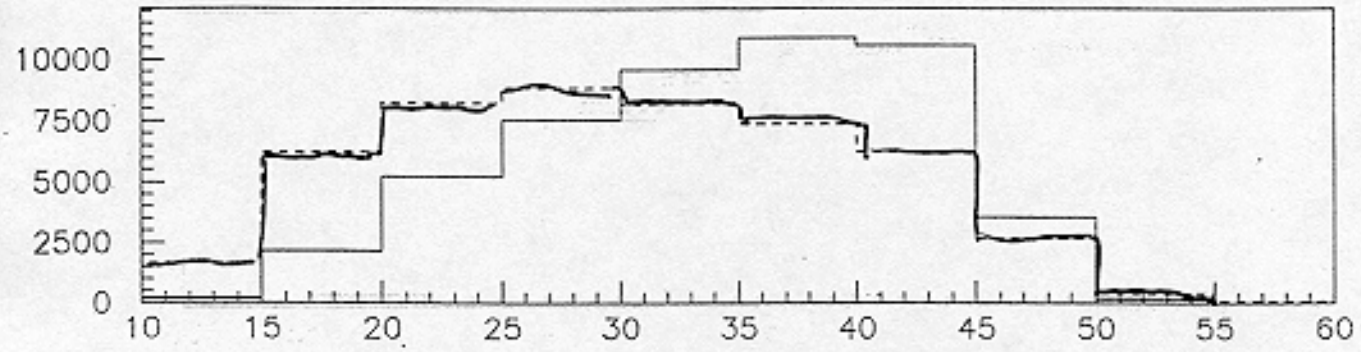

0.08
0.06
0.04
0.02
0
10 15 20 25 30 35 40
$M_{g\bar{b}b}$
$M_{g\to b\bar{b}}$ (GeV)


0.08
0.06
0.04
0.02
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
$\cos\vartheta^*_{g\bar{b}b}$
$\cos\theta^*_{g\to b\bar{b}}$


b
θ*
g
b̄

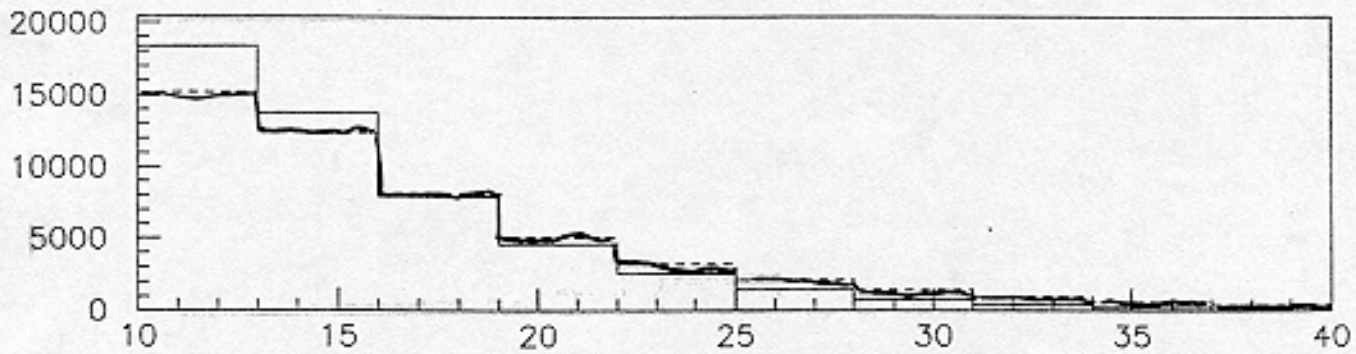
Ω: Jetset (PS)

Ω: 〃 (ME)



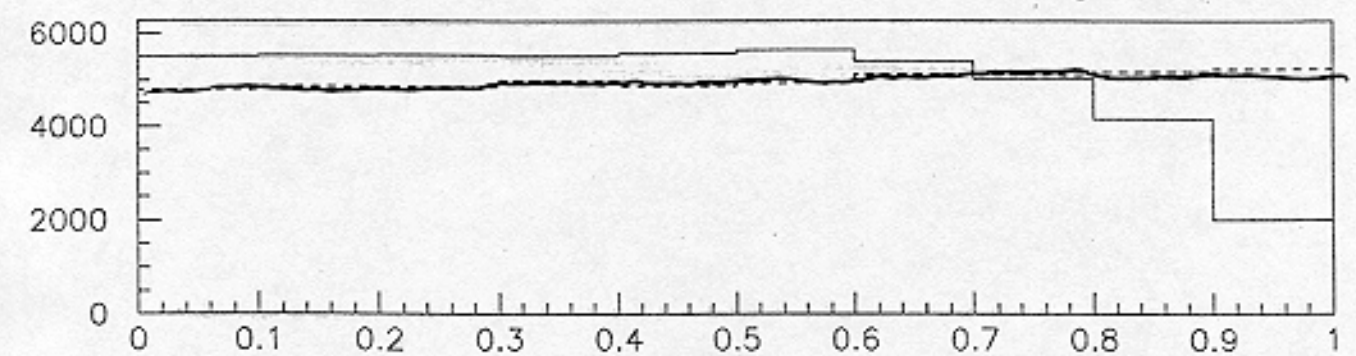
E_{gbb}(GeV)

$E_{g\to b\bar{b}}$ (GeV)



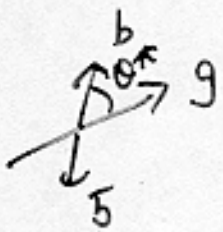
M_{gbb}(GeV)

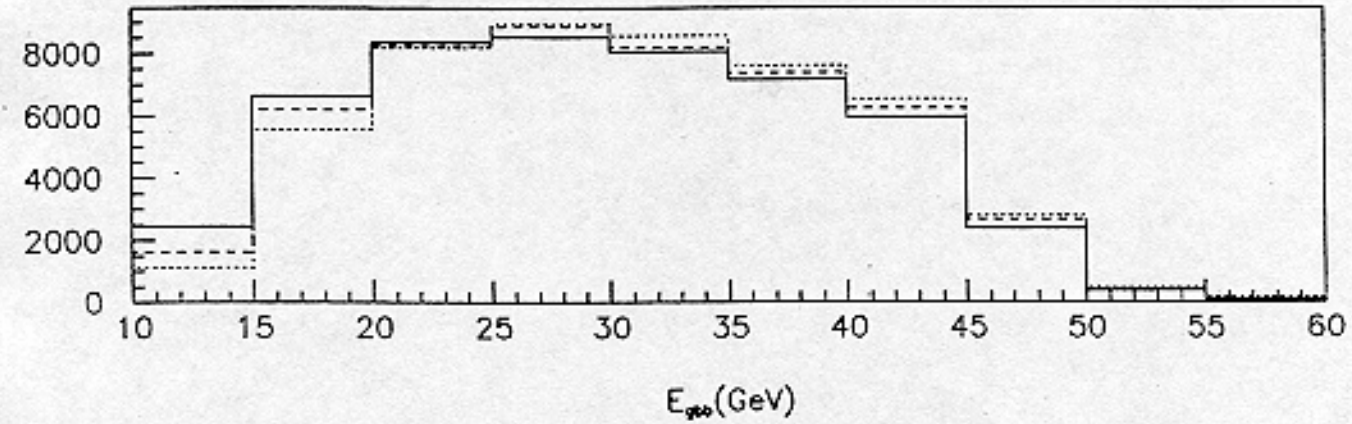
$M_{g\to b\bar{b}}$ (GeV)

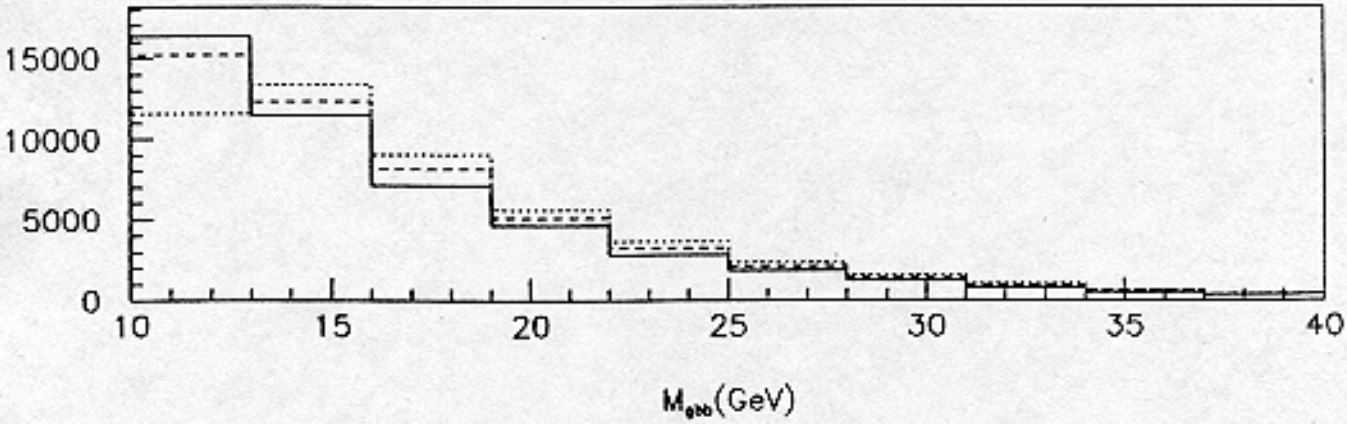


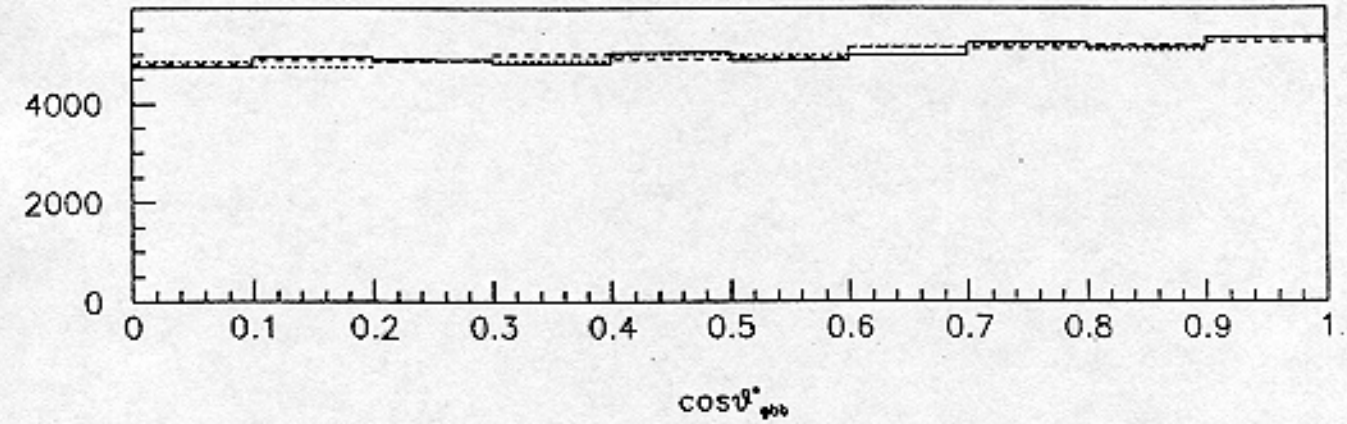
$\cos\vartheta^*_{gbb}$

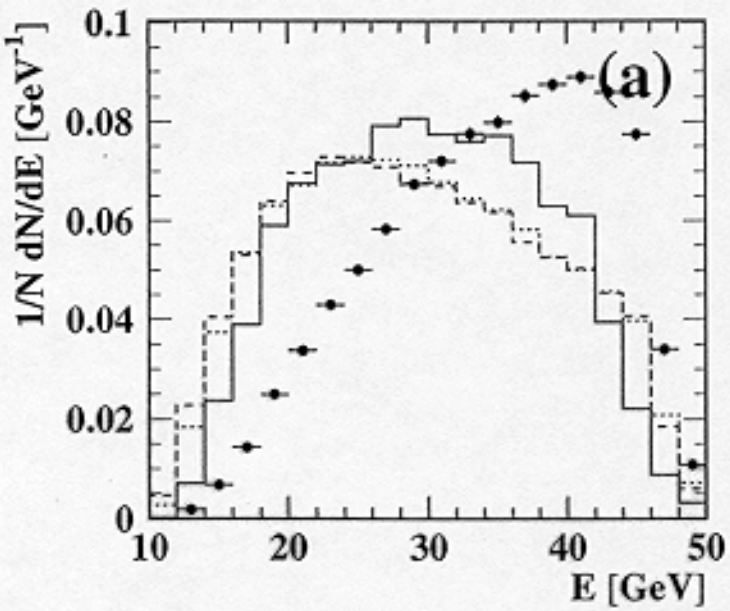
$\cos\theta^*_{g\to b\bar{b}}$

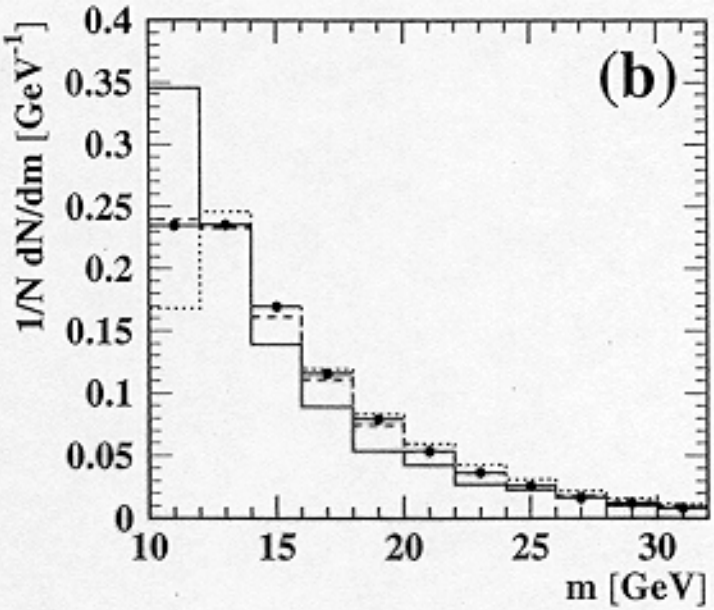


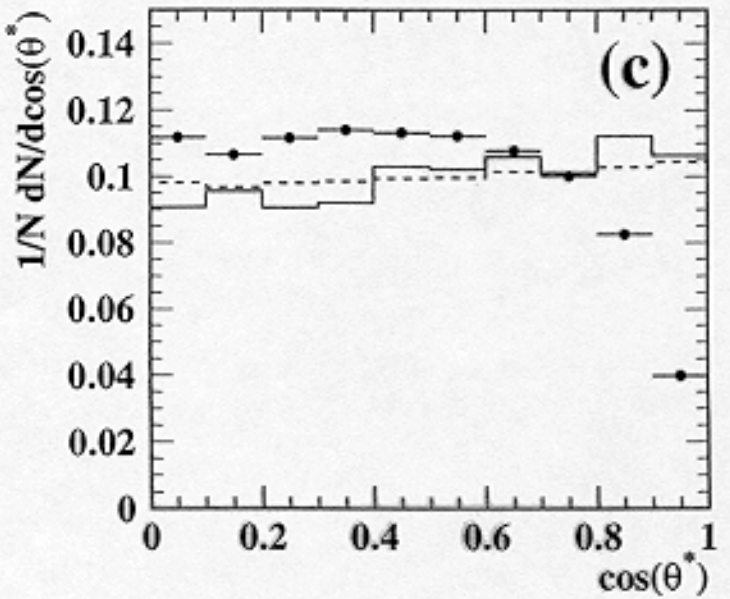

8000
6000
4000
2000
0
10
15
20
25
30
35
40
45
50
55
60
$E_{\phi\phi}$(GeV)

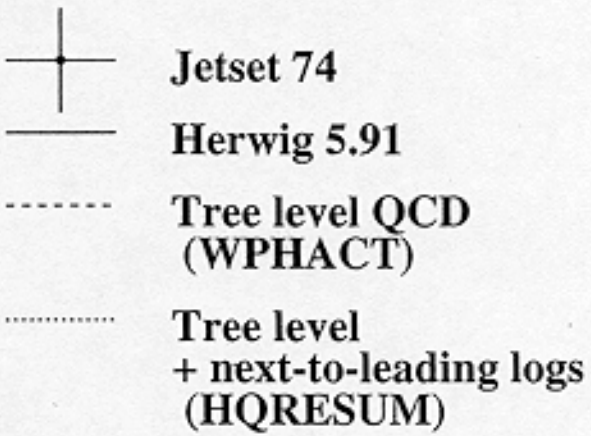

15000
10000
5000
0
10
15
20
25
30
35
40
$M_{\phi\phi}$(GeV)


4000
2000
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
$\cos\vartheta^*_{\phi\phi}$









Taking difference between Jetset (PS) and Herwig for the systematic error is world standard.

Summary

New preliminary result.

$$g_{b\bar{b}} = 2.87 \pm 0.61\,(\text{Stat.}) \pm 0.65\,(\text{Sys.})$$

$$3.07 \pm 0.71 \qquad \pm 0.66\,(\text{old}).$$