New SUSY Results with Missing Energy at CDF

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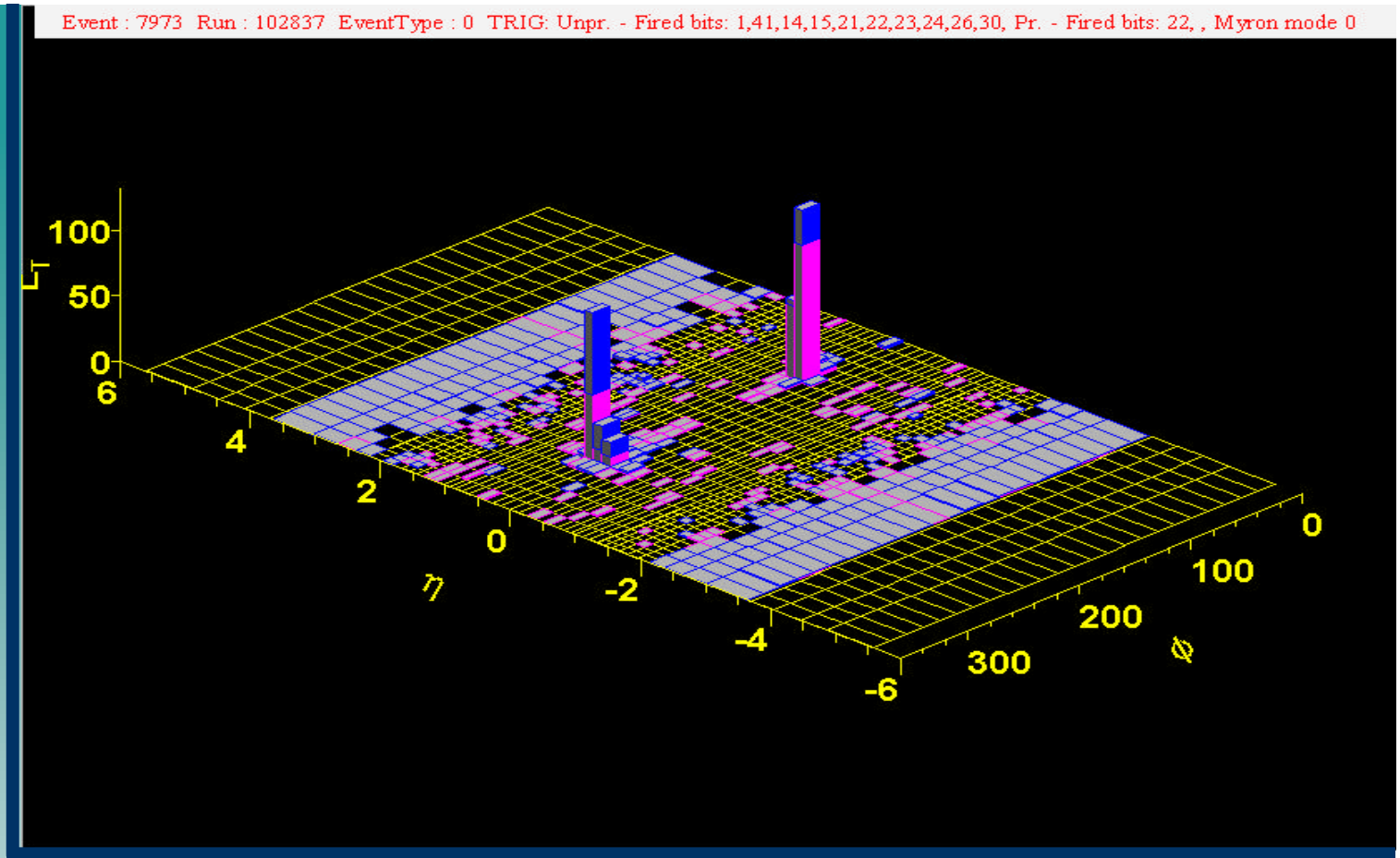
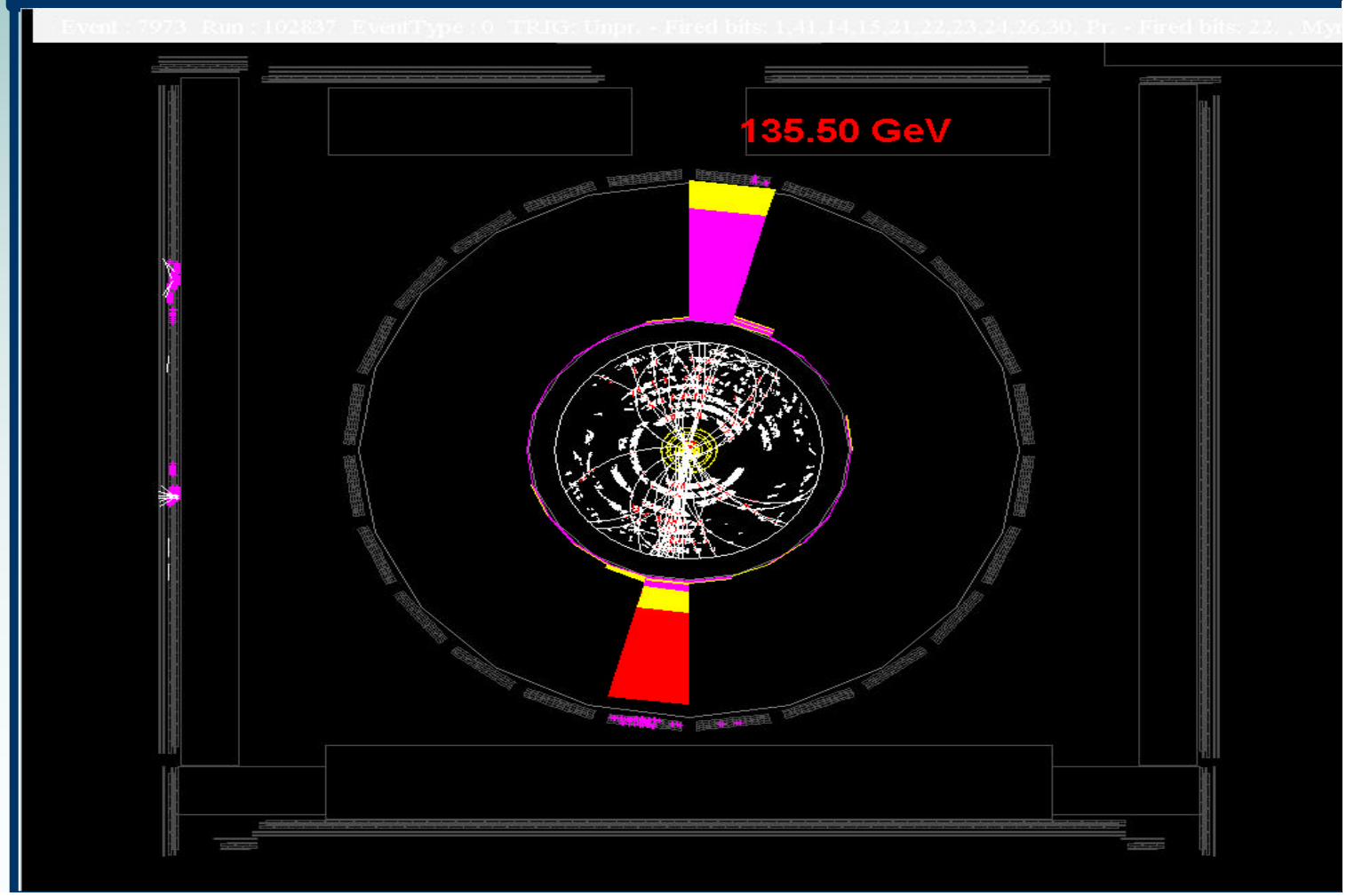
Dec 14 2000

BNL Particle Physics Seminar


Event : 7973 Run : 102837 EventType : 0 TRIG: Unpr. - Fired bits: 1,41,14,15,21,22,23,24,26,30, Pr. - Fired bits: 22, , Myron mode 0
100
50
0
E_T
6
4
2
0
-2
-4
-6
η
0
100
200
300
φ

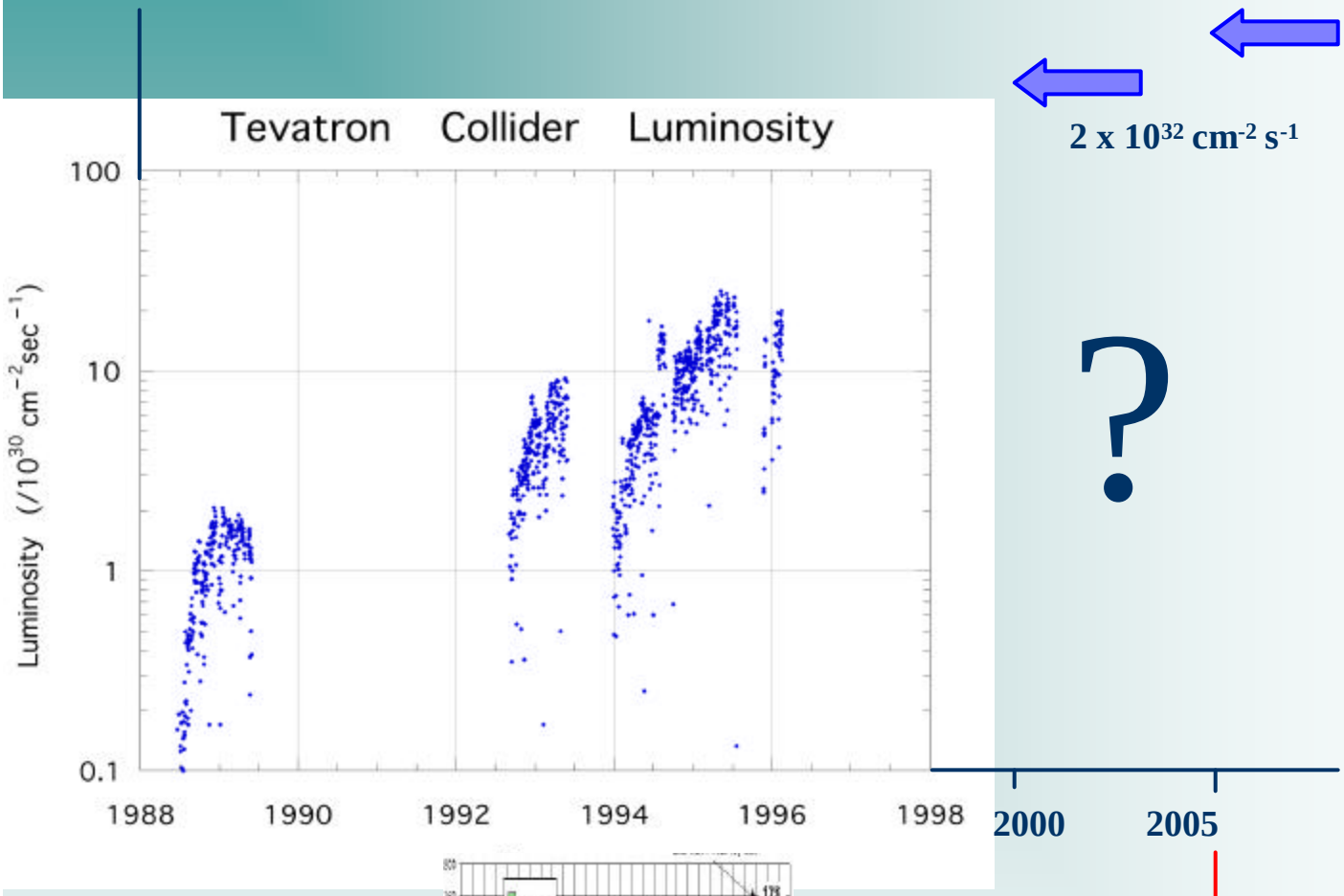

135.50 GeV

evatron

otons run the 4 mile ring
about 50000/sec

Tevatron

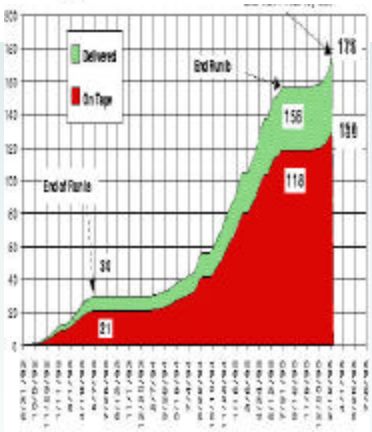
Discovery of top, B_c



2×10^{32} cm^{-2} s^{-1}

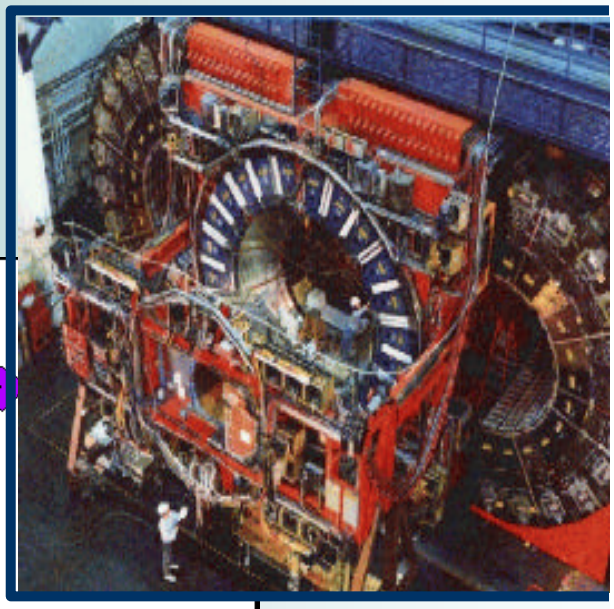
?

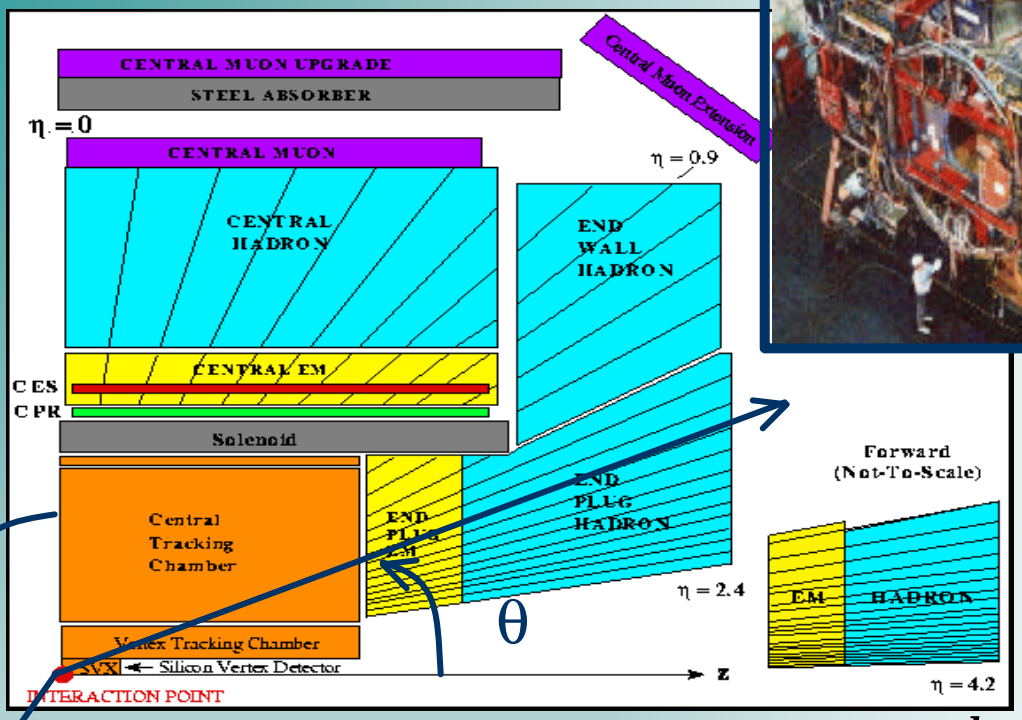
15 fb^{-1}



100pb^{-1}

Missing E_T





$$\vec{E}_T + \sum \vec{E}_T = \vec{0}$$

$$h = -\log(\tan\frac{q}{2})$$

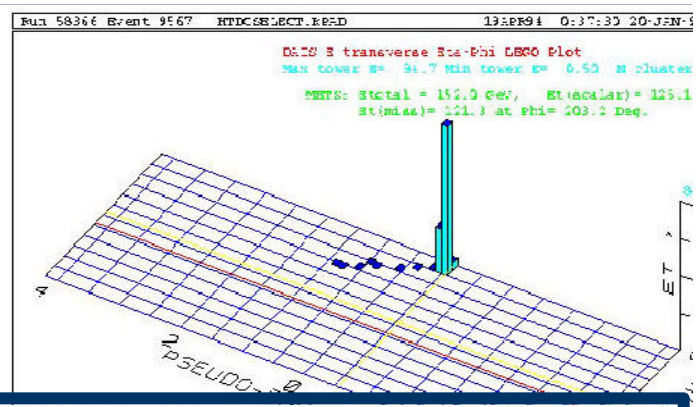
$$-4.2 < h < 4.2$$

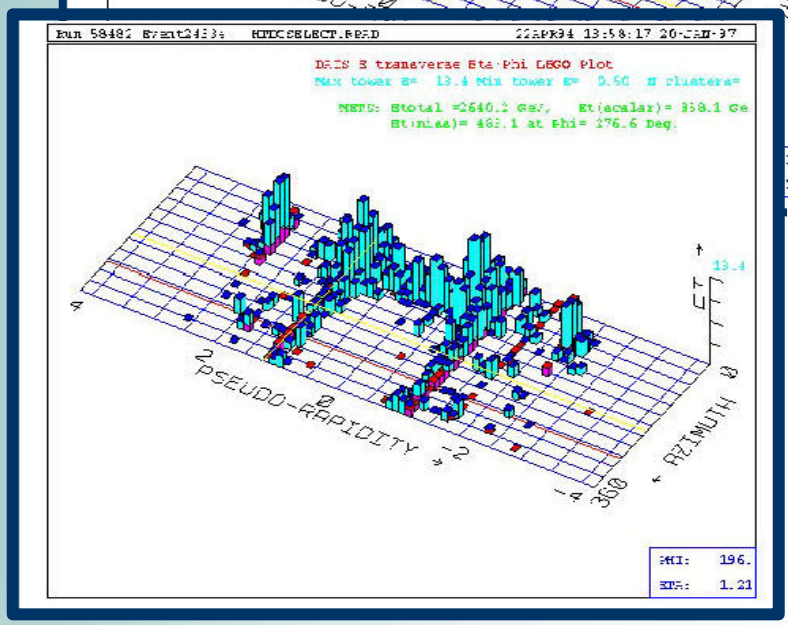
$$\left(\begin{array}{l} \not{E}^{x}{}_{T} = -\sum_i E^{i}{}_{T} \cos(q_i) \\ \not{E}^{y}{}_{T} = -\sum_i E^{i}{}_{T} \sin(q_i) \end{array} \right)$$

Missing Energy provides the classic R-parity conserving SUSY signature ($R=(-1)^{3B+L+2S}$) but appears in many other phenomenological paradigms

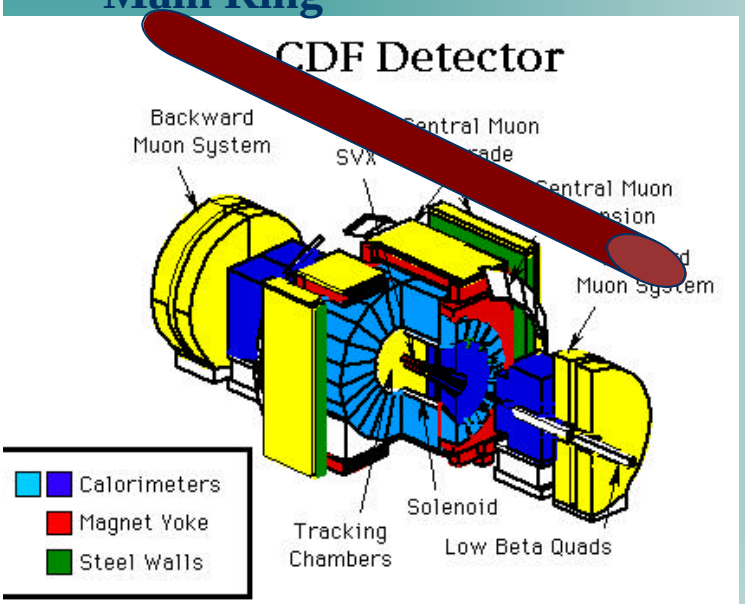
MET + 3 jets (squarks,gluinos) , MET + c-tagged jets (scalar top) MET + b-tagged jets (scalar bottom,Higgs), MET + monojet (gravitino graviton) MET + photons (gravitino)

Fake Missing Energy





Main Ring



INSTRUMENTAL SOURCES OF MISSING ENERGY

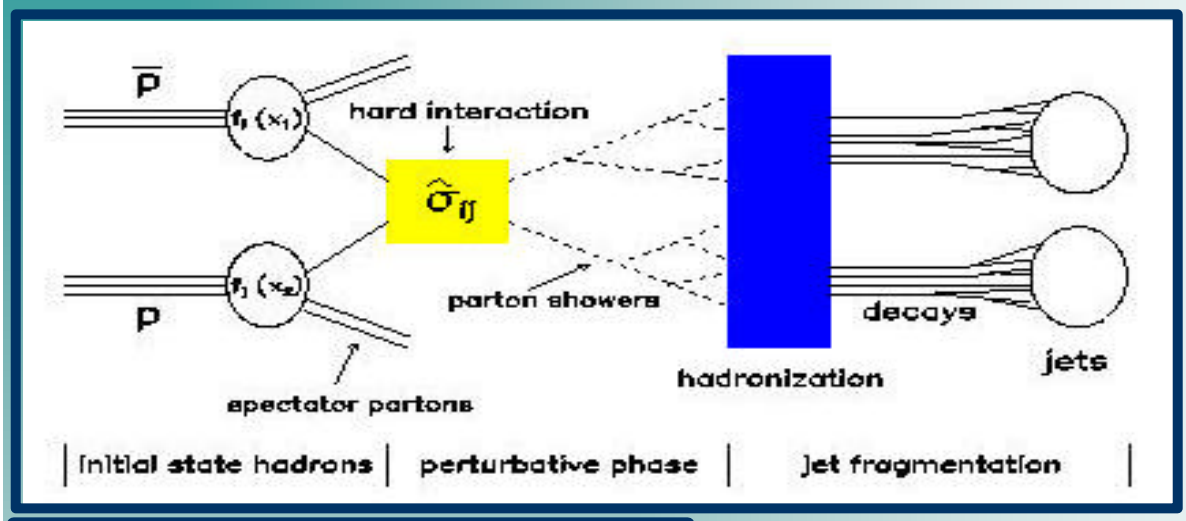
MAIN RING

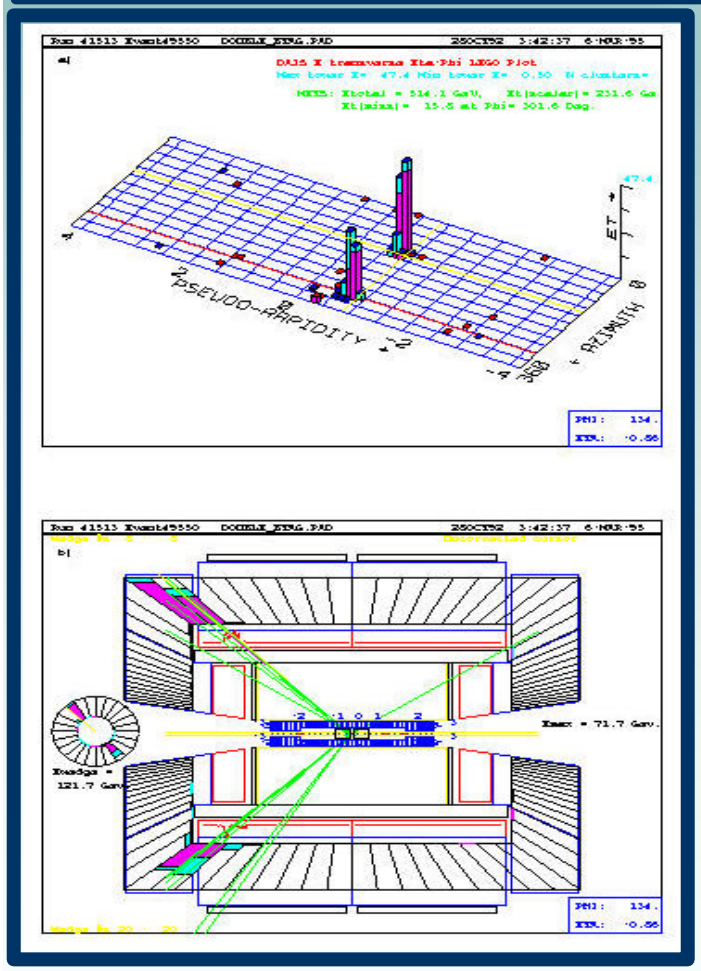
DETECTOR MALFUNCTIONS/NOISE

COSMICS

These are eliminated with a set of timing and good jet quality requirements

Jets



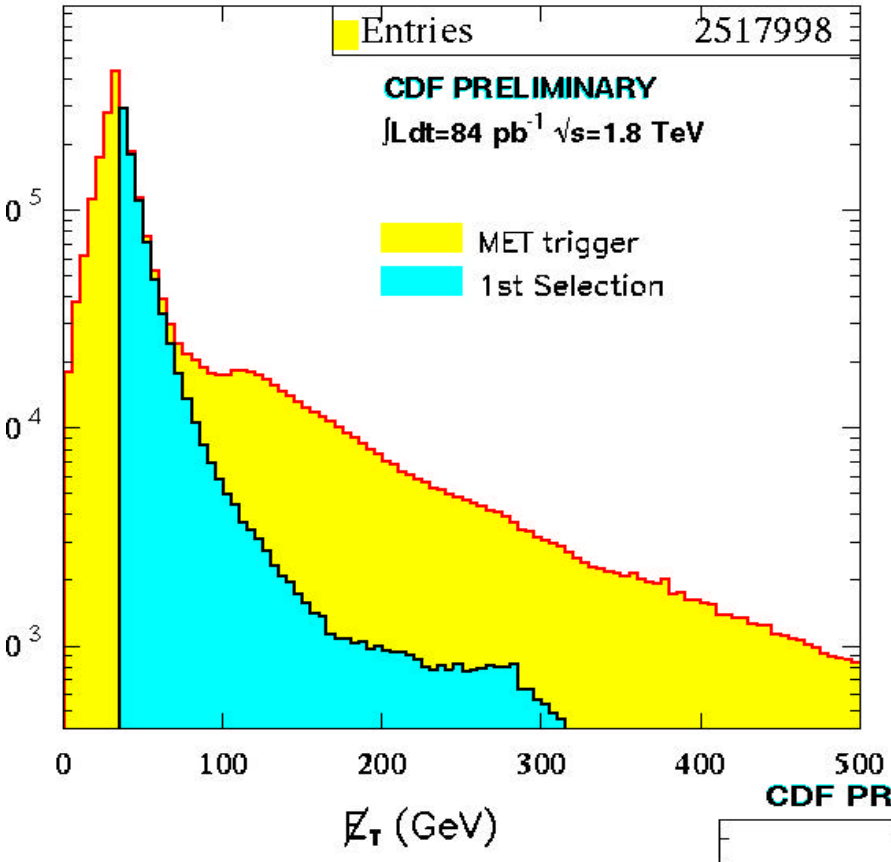


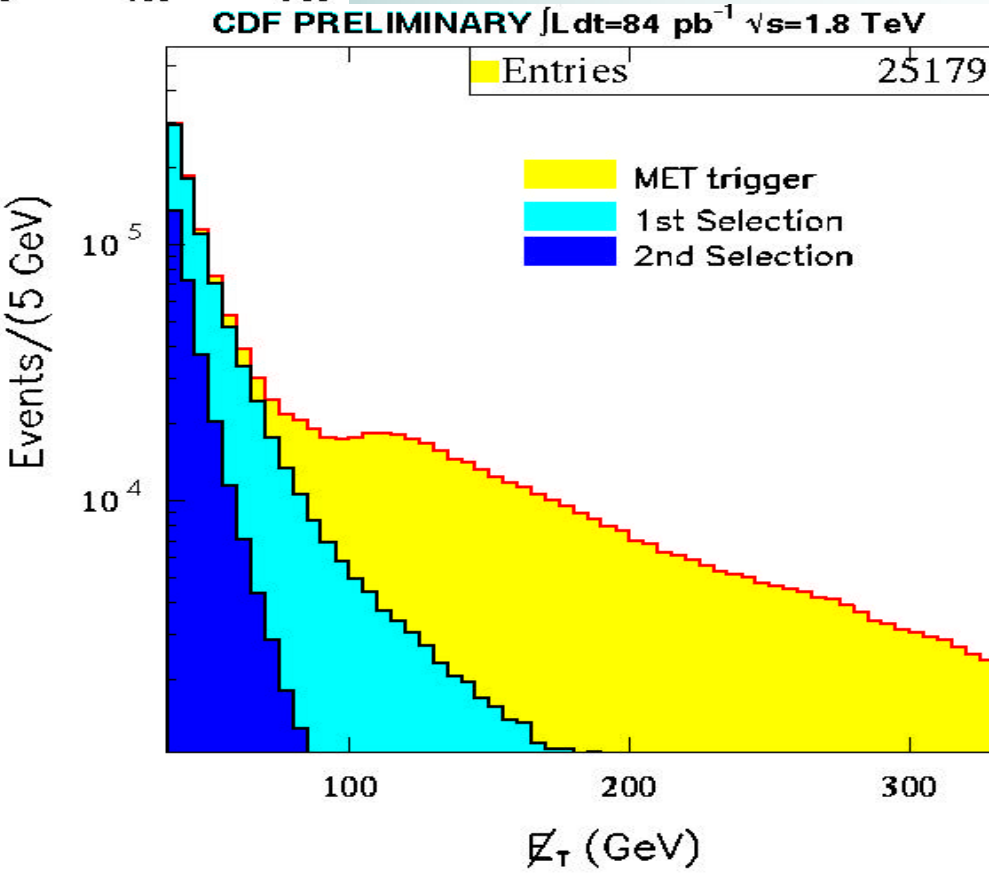
Jet variables used for "good jetiness" criteri

*** Charge Fraction (CH**

*** EM fraction (EMF)**

ATA PRE-SELECTION



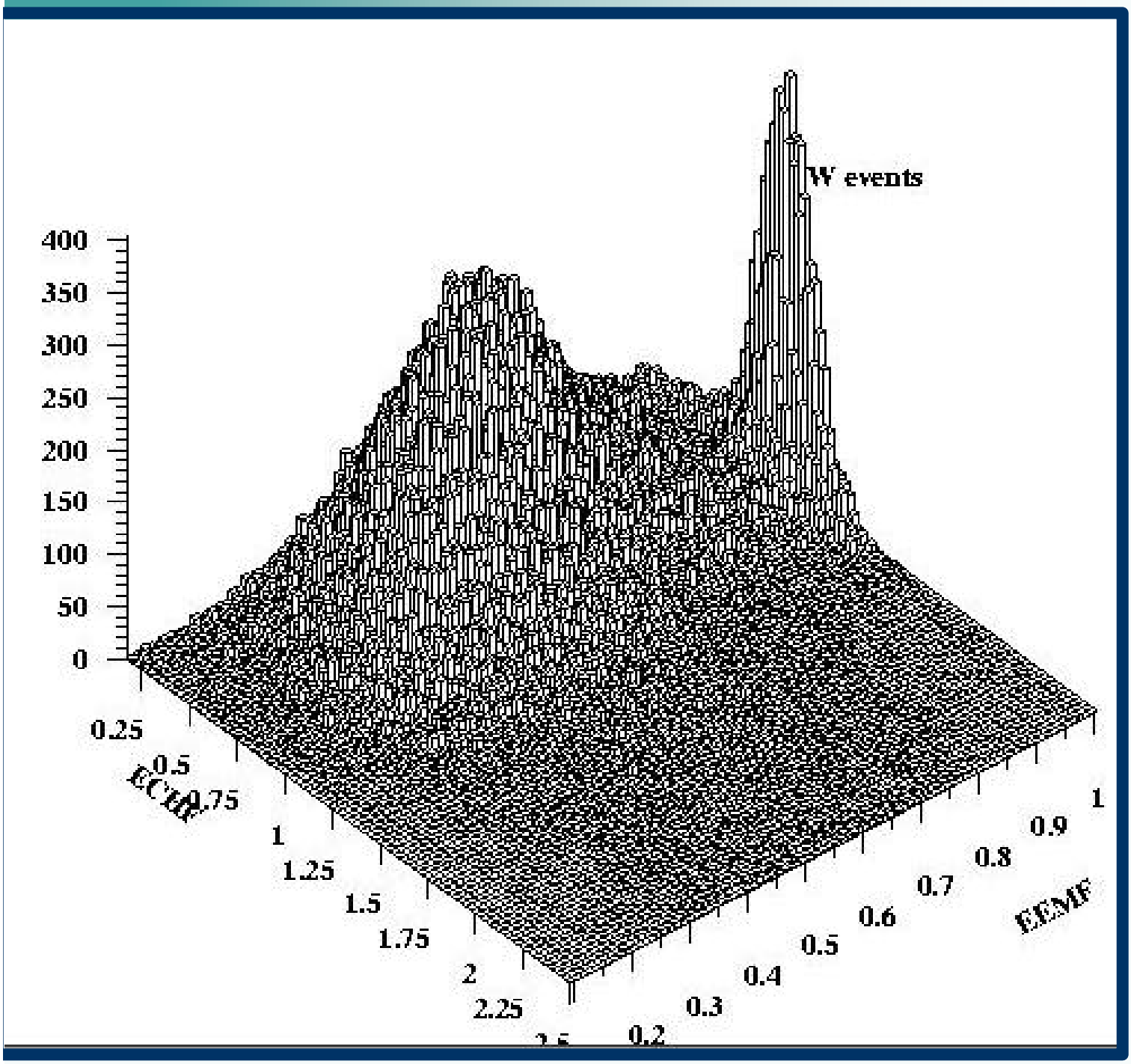


ATA PRE-SELECTION

of 2517998 events	Number of events fail
$\not\!\!E_T$	1123734
Out-Time	506241
Stage 1 $=\not\!\!E_T \oplus$ Out-Time	1625603
Total passing Stage 1	892395

of 892394 events	Number of Events Fail
1 central jet	372978
EEMF	24992
ECHF	591449
Total passing Stage 2	300945

See the W's !!


W events
400
350
300
250
200
150
100
50
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
EEMF

ISSING ENERGY + MULTIJET
TANDARD MODEL COMPONENT

$Z(\rightarrow ll) + jets$

$W(\rightarrow ln) + jets$

$t\bar{t}$, single top

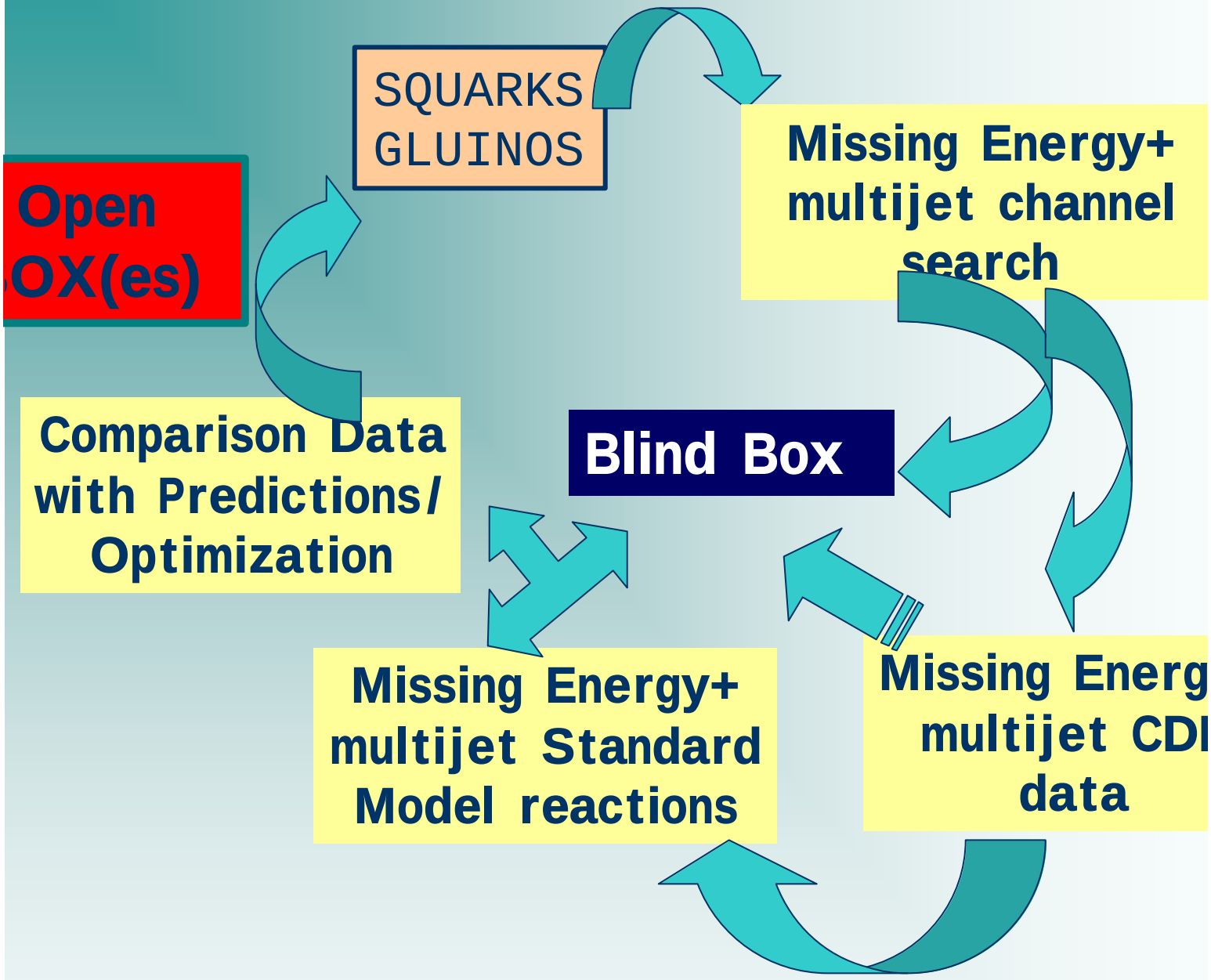
Diboson

QCD multijet

EWK

Note: The missing energy is a QCD sample

SEARCH OUTLINE



SQUARK
GLUINO

SUPERSYMMETRY Fermion❖Boson

Solves the “hierarchy problem”

Apparently Unifies the three gauge couplings

$R=(-1)^{3(B-L)+2S}$ +1 (SM particles)
-1 SUSY particles

If R-parity is conserved
- sparticles are produced in pairs and eventually decay to the Lightest SUSY Particle (LSP)
- the LSP is stable and weakly interacting
- ⇏ **missing energy signature**

LSP is a good candidate for dark matter

Name	Spin	R	Mass Eigenstates	Gauge Eigenstat
iggs bosons	0	+1	$h^0\ H^0\ A^0\ H^\pm$	$H_u^0\ H_d^0\ H_u^+\ H_d^-$
squarks	0	−1	$\tilde{u}_L\ \tilde{u}_R\ \tilde{d}_L\ \tilde{d}_R$ $\tilde{s}_L\ \tilde{s}_R\ \tilde{c}_L\ \tilde{c}_R$ $\tilde{t}_1\ \tilde{t}_2\ \tilde{b}_1\ \tilde{b}_2$	$\tilde{u}_L\ \tilde{u}_R\ \tilde{d}_L\ \tilde{d}_R$ $\tilde{s}_L\ \tilde{s}_R\ \tilde{c}_L\ \tilde{c}_R$ $\tilde{t}_L\ \tilde{t}_R\ \tilde{b}_L\ \tilde{b}_R$
sleptons	0	−1	$\tilde{e}_L\ \tilde{e}_R\ \tilde{\nu}_e$ $\tilde{\mu}_L\ \tilde{\mu}_R\ \tilde{\nu}_\mu$ $\tilde{\tau}_1\ \tilde{\tau}_2\ \tilde{\nu}_\tau$	$\tilde{e}_L\ \tilde{e}_R\ \tilde{\nu}_e$ $\tilde{\mu}_L\ \tilde{\mu}_R\ \tilde{\nu}_\mu$ $\tilde{\tau}_L\ \tilde{\tau}_R\ \tilde{\nu}_\tau$
neutralinos	1/2	−1	M1 $\tilde{\chi}_1^0\ \tilde{\chi}_2^0\ \tilde{\chi}_3^0\ \tilde{\chi}_4^0$	$\widetilde{B}^0\ \widetilde{W}^0\ \widetilde{H}_u^0\ \widetilde{H}_d^0$
charginos	1/2	−1	M2 $\tilde{\chi}_1^\pm\ \tilde{\chi}_2^\pm\ \tilde{\chi}_3^\pm$	$\widetilde{W}^\pm\ \widetilde{H}_u^+\ \widetilde{H}_d^-$
gluino	1/2	−1	M3 $\tilde{g}$	$\tilde{g}$
gravitino/ goldstino	3/2	−1	$\tilde{G}$	$\tilde{G}$

The Super-Models

SSM

$m_{\tilde{g}}$ gluino mass

μ Higgs mass parameter

$\tan\beta \quad \frac{\upsilon_2}{\upsilon_1}$

A mass of CP - odd Higgs

$m_{\tilde{l}}, m_{\tilde{q}}$ slepton and squark masses

$A_{\tilde{l}}, A_{\tilde{q}}$ trilinear couplings

SUGRA

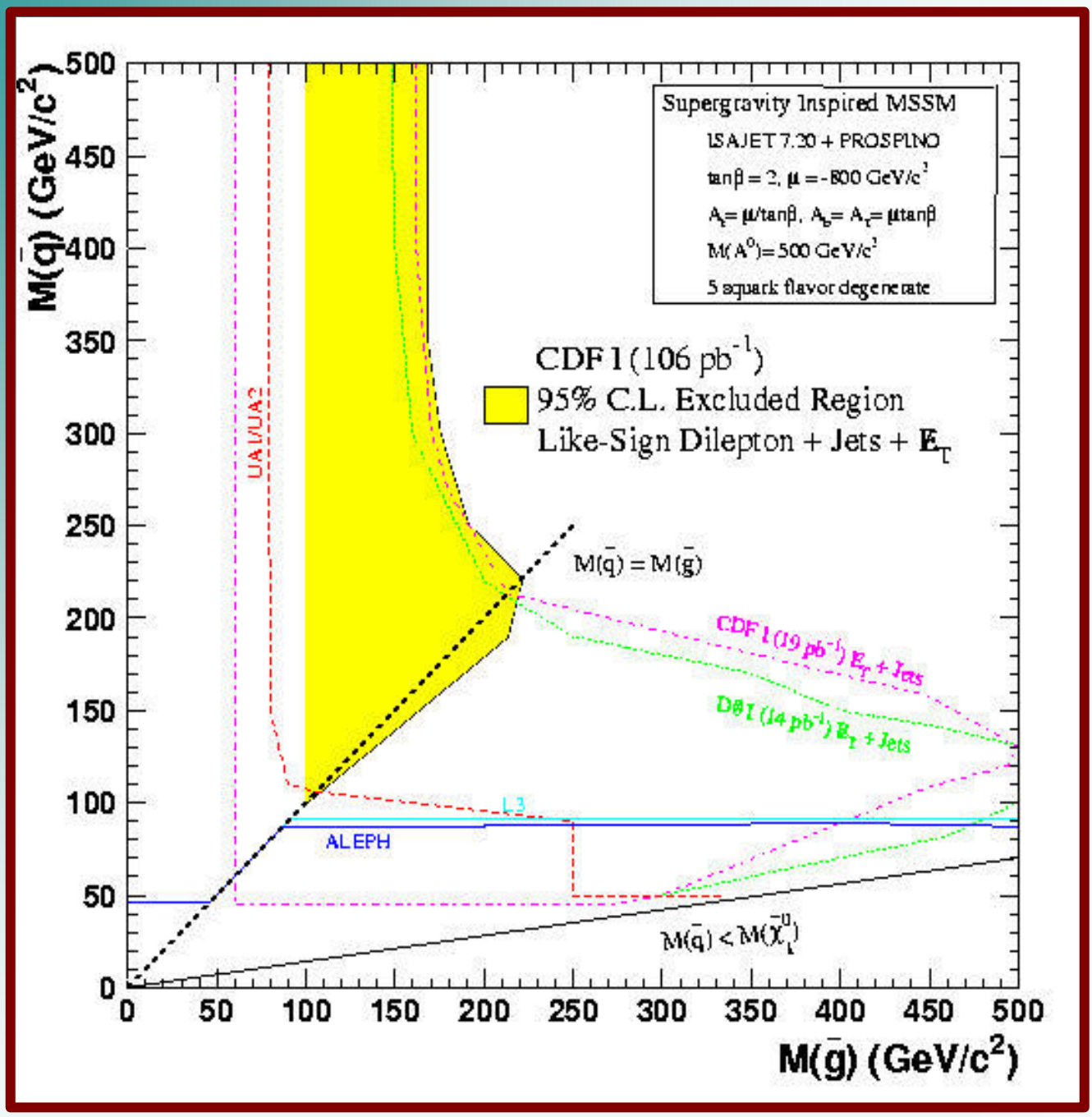
$M_{1/2}$ unified gaugino masses

M_0 unified scalar masses

$\tan\beta \quad \frac{\upsilon_2}{\upsilon_1}$

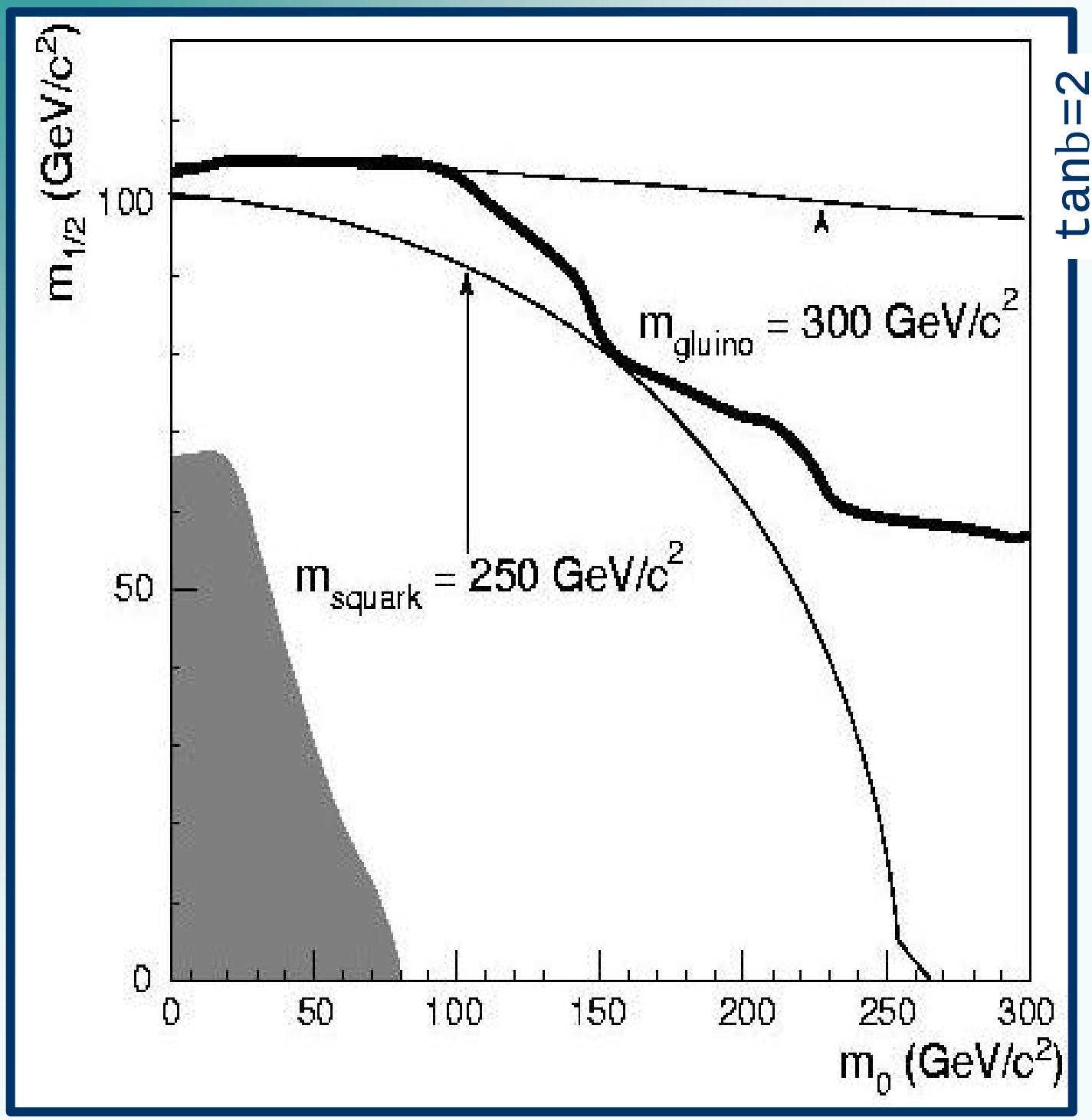
A_0 unified trilinear couplings

sign μ

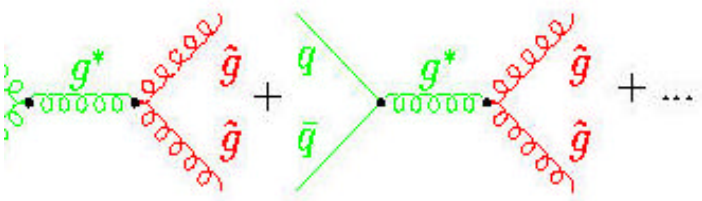


Present Results

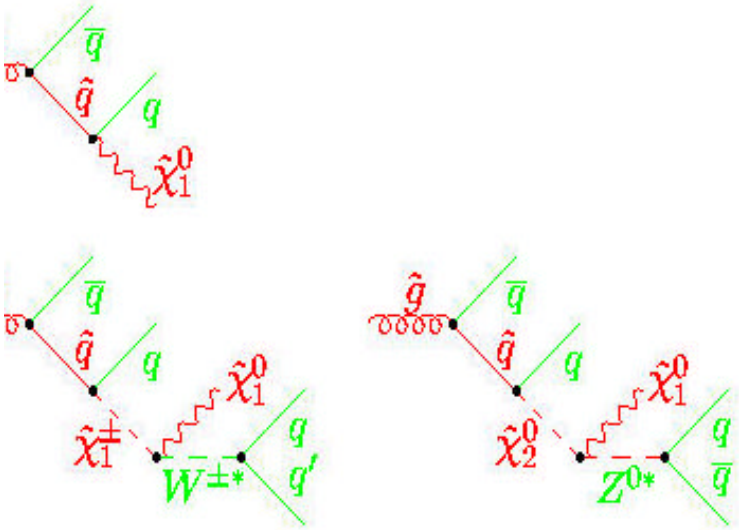
mSUGRA DØ result



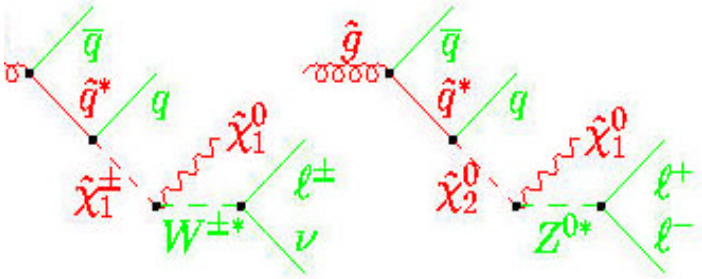
Production/Decay Graphs



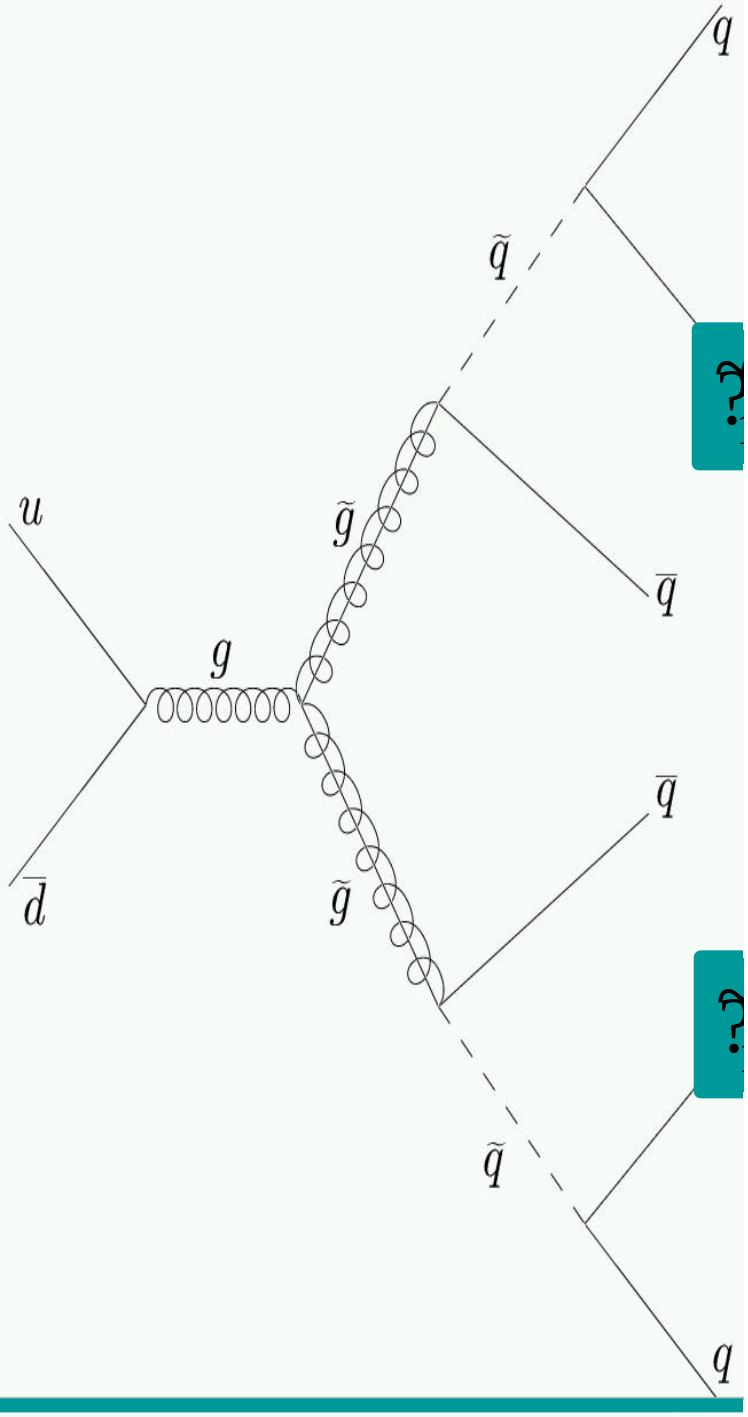
Production of squarks and gluinos

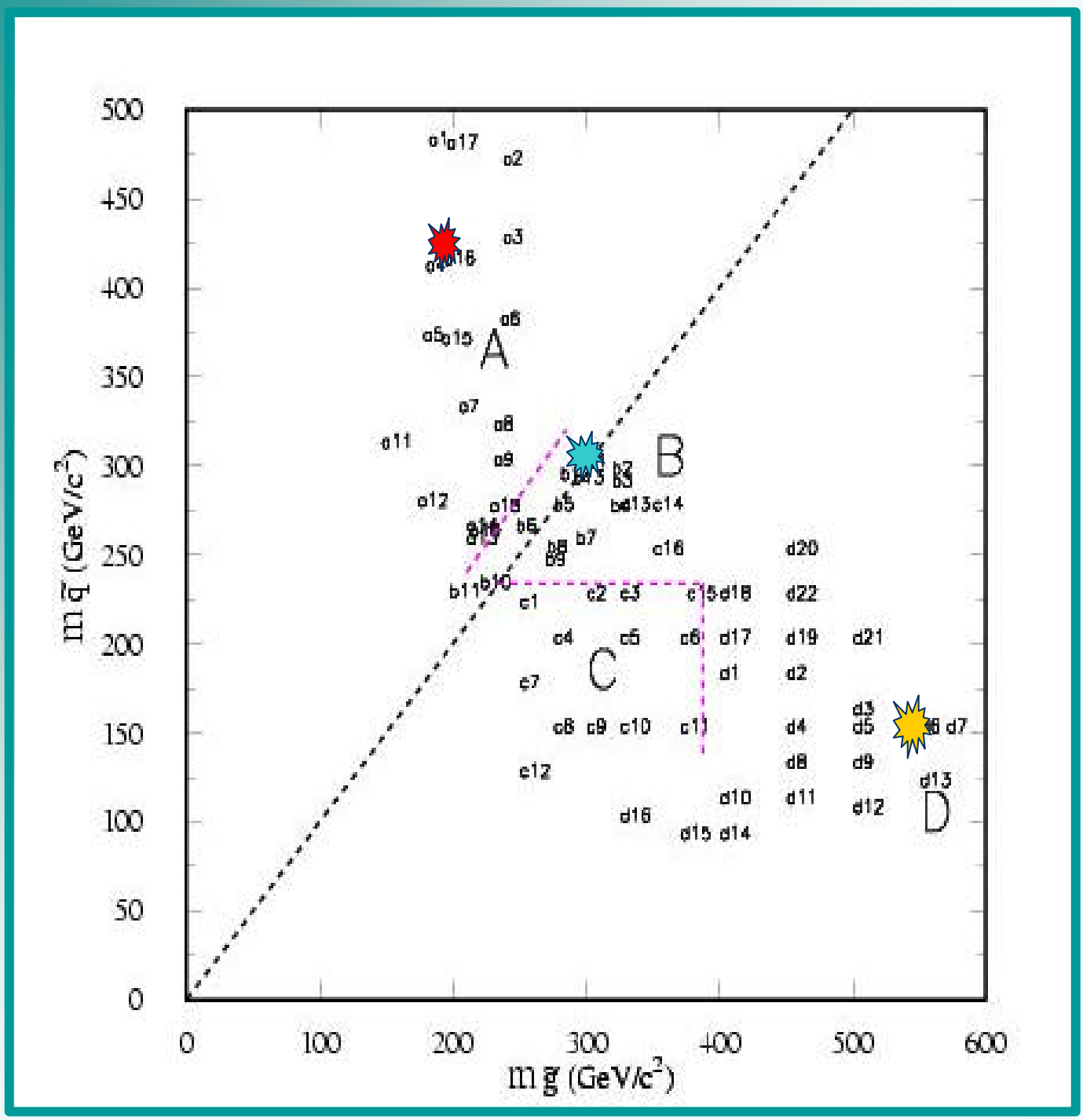


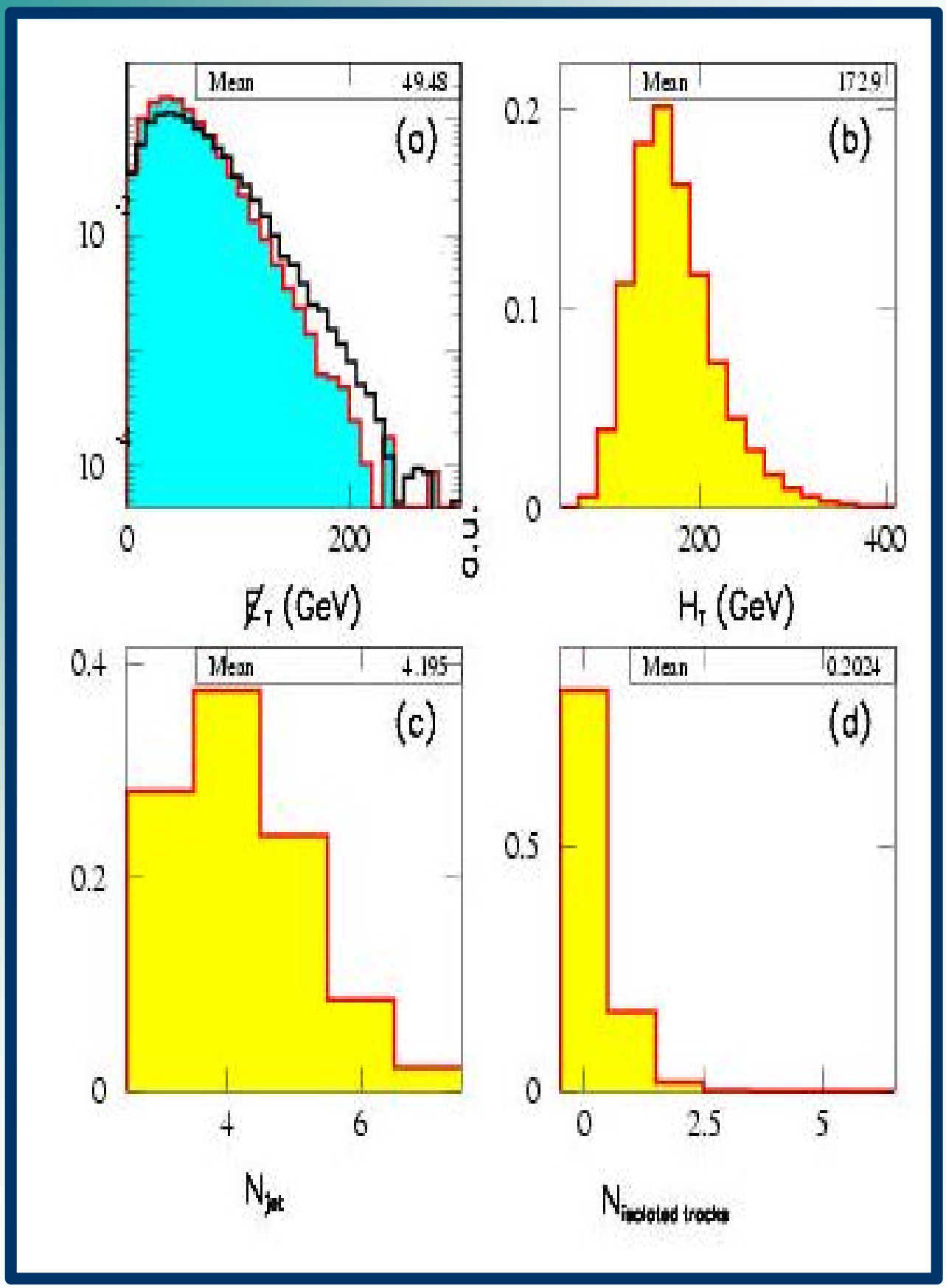
Decay of gluino to jets

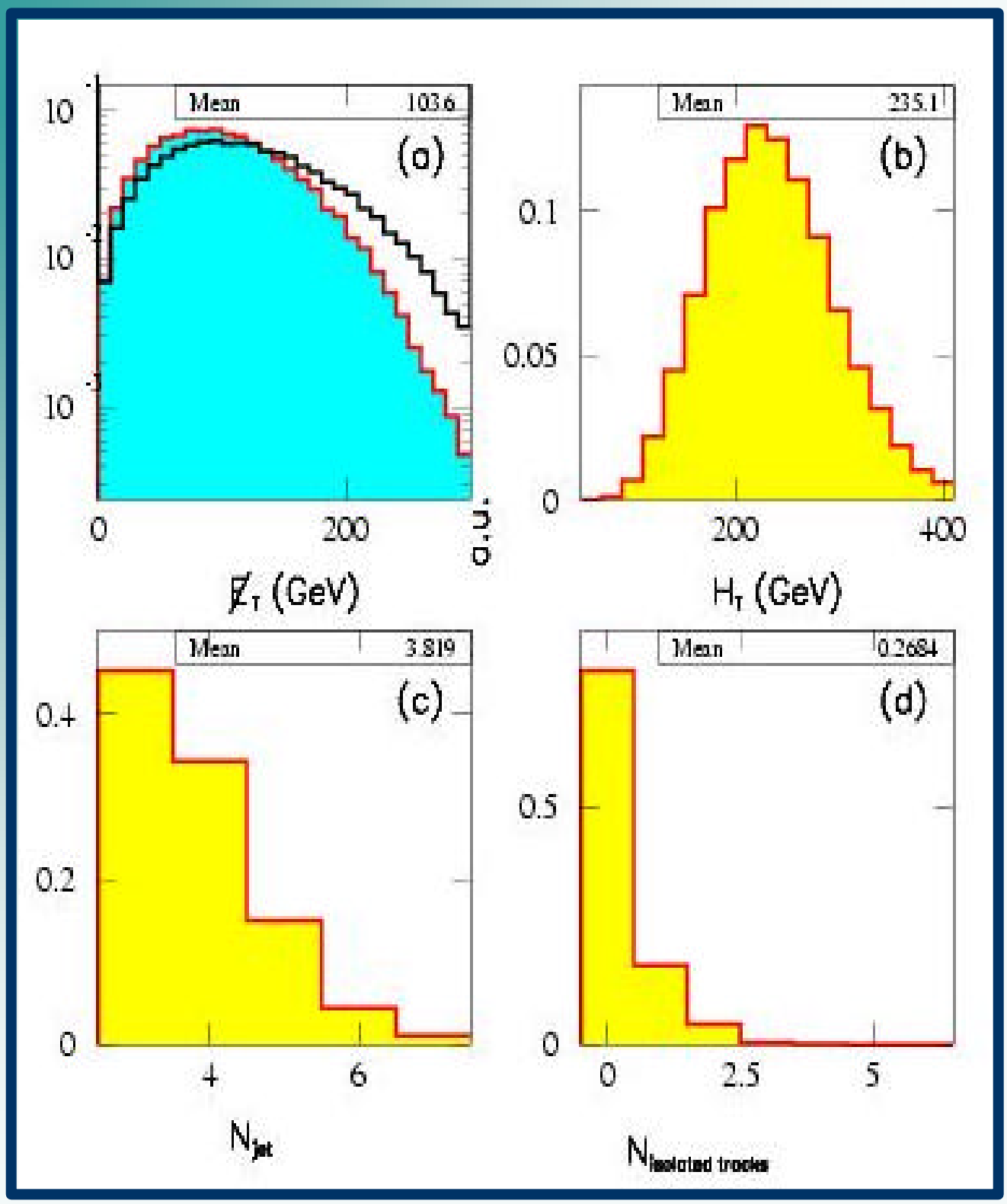


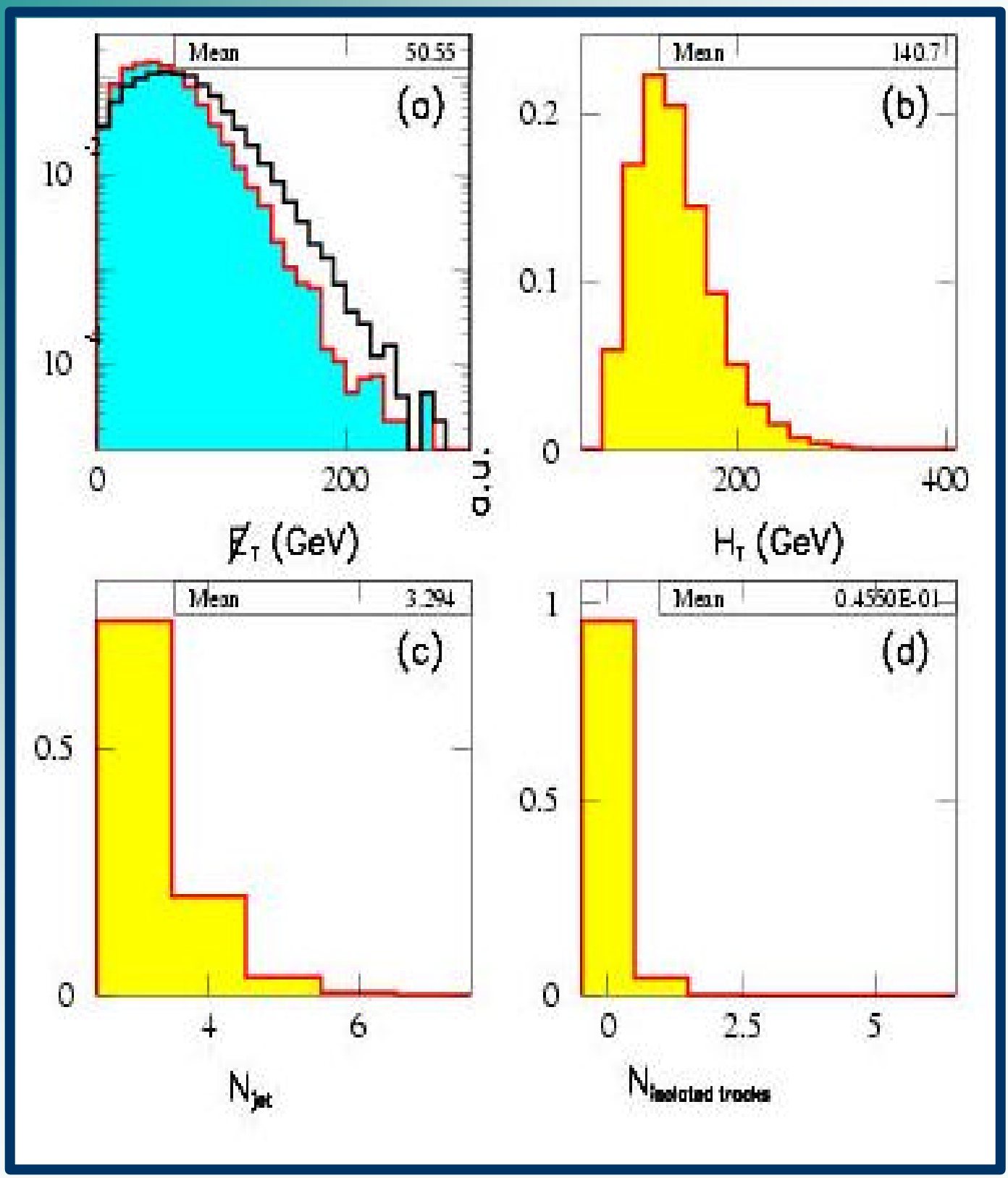
Decay of gluinos to leptons




m q̃ (GeV/c²)
m g̃ (GeV/c²)
A
B
C
D


Mean
49.48
(a)
10
10
0
200
a.u.
$\not{E}_T$ (GeV)
Mean
172.9
(b)
0.2
0.1
0
200
400
H_T (GeV)
Mean
4.195
(c)
0.4
0.2
0
4
6
N_{jet}
Mean
0.2024
(d)
0.5
0
0
2.5
5
$N_{isolated\ tracks}$


Mean 103.6
(a)
$\not{E}_T$ (GeV)
Mean 235.1
(b)
H_T (GeV)
Mean 3.819
(c)
N_{jet}
Mean 0.2684
(d)
$N_{isolated\ tracks}$


Mean 50.55
(a)
10
10
0
200
n.u.
$\not{E}_T$ (GeV)
Mean 140.7
(b)
0.2
0.1
0
200
400
H_T (GeV)
Mean 3.294
(c)
0.5
0
4
6
N_{jet}
Mean 0.4560E-01
(d)
1
0.5
0
0
2.5
5
$N_{isolated\ tracks}$

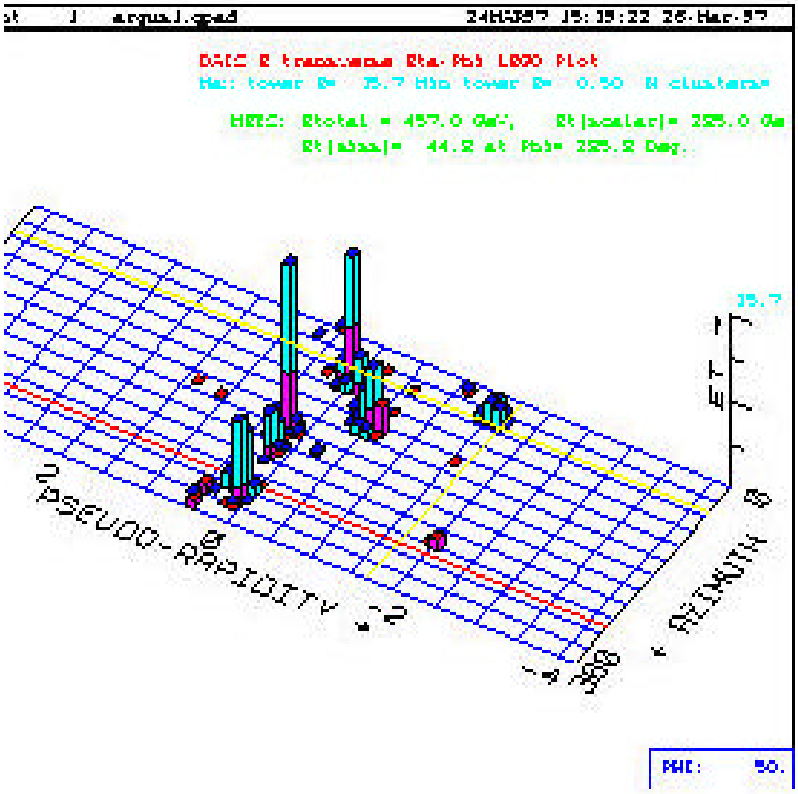
NALYSIS DRIVING VARIABLES

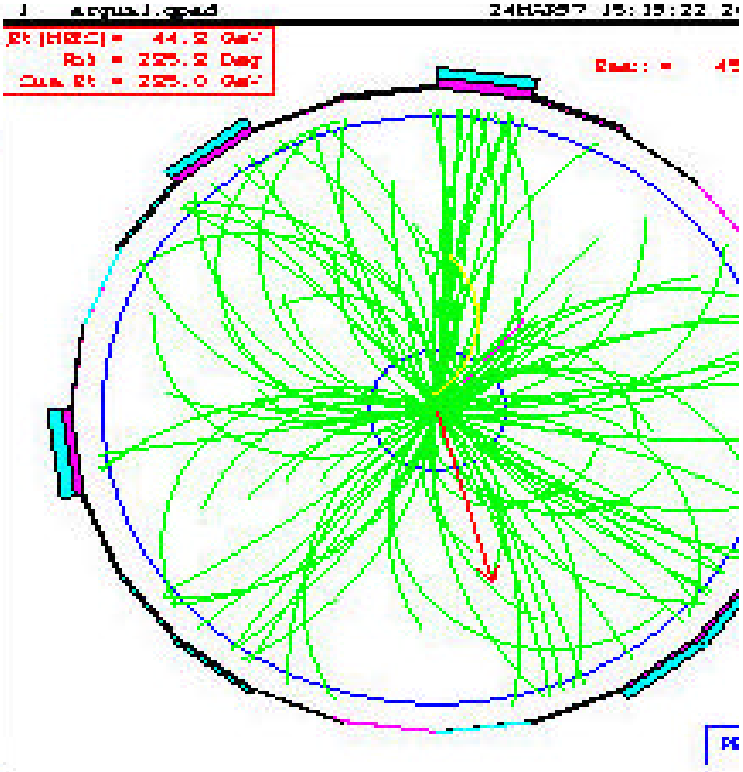
he Missing Transverse Energy $\not\!\!E_T$

he Number of Jets N_{je}

$E_T(2^{nd\,jet})+E_T(3^{rd\,jet})+\not\!\!E_T$ H_T

he Number of isolated tracks N_{tr}^{is}


argus1.gpsd
24MAR87 15:15:22 26-Mar-87
DATC R transverse Rha-Rbl LEGO Plot
ET
PSEUDO-RAPIDITY
AZIMUTH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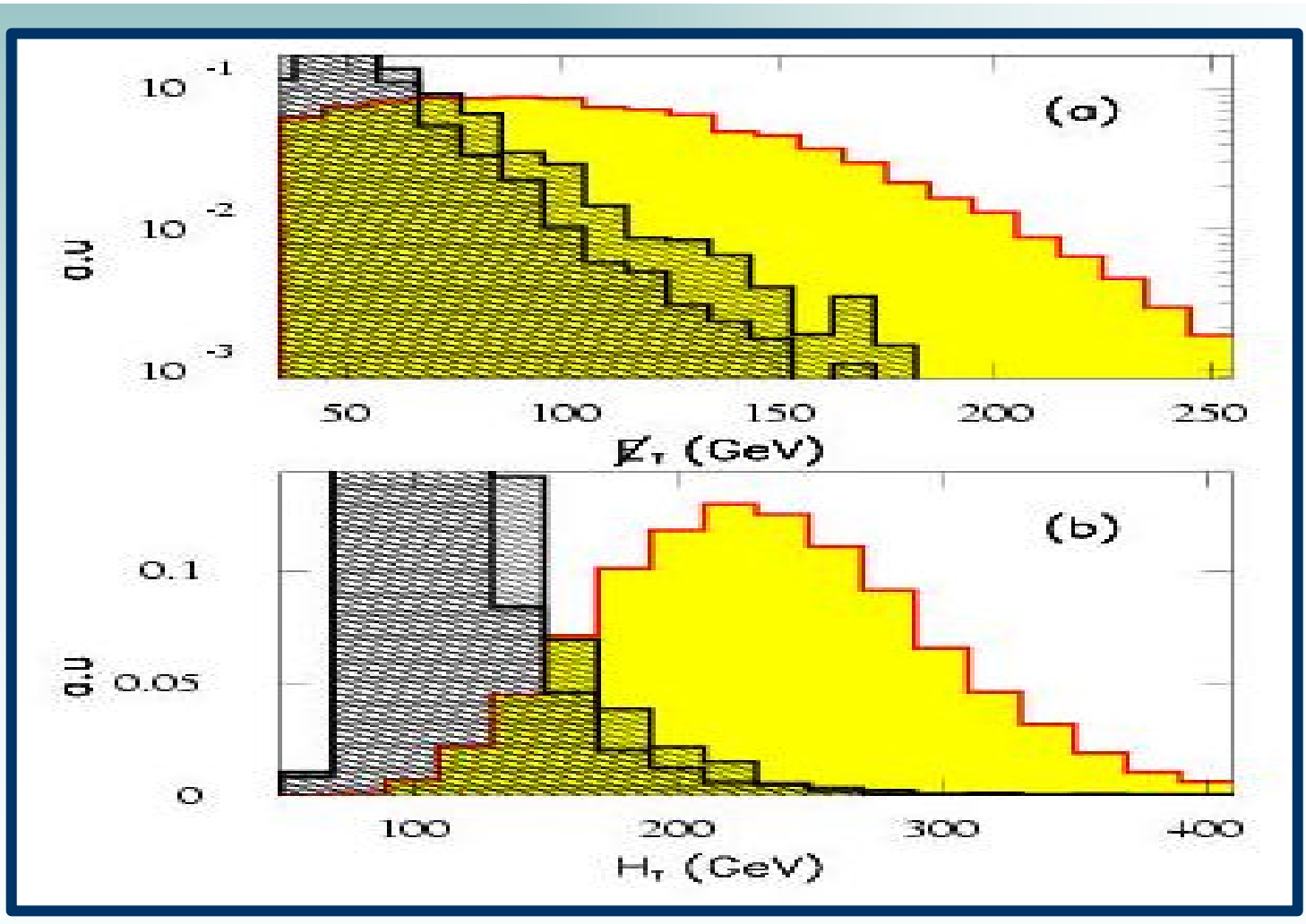
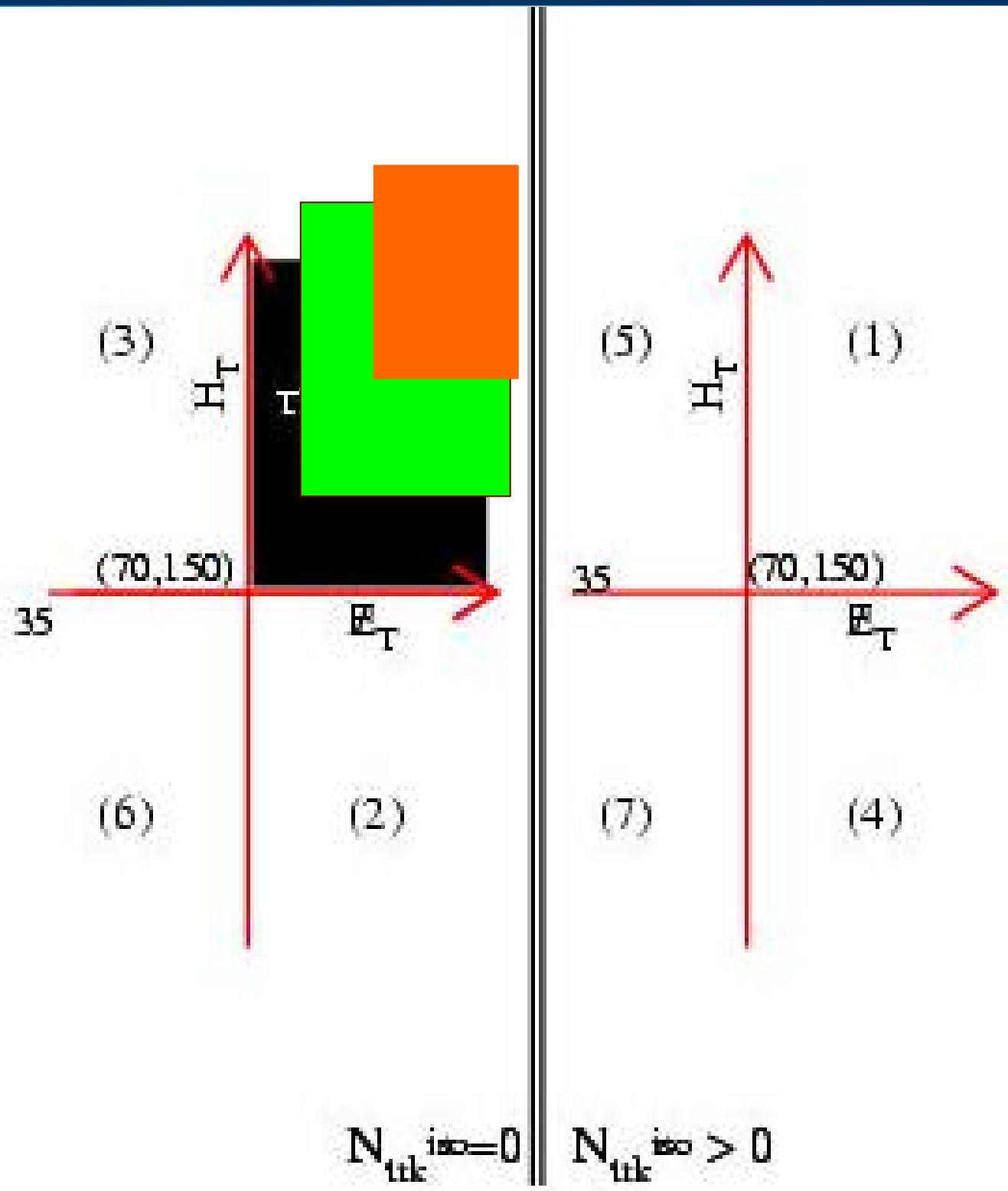
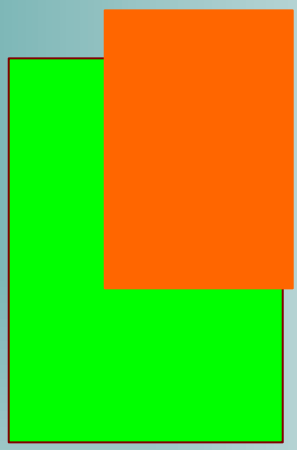
24MAR87 15:15:22


(a)
$\not\!\!E_T$ (GeV)
(b)
H_T (GeV)

"The BOX"


(3)
H_T
(70,150)
35
$\not\!\!E_T$
(6)
(2)
$N_{ttk}^{iso=0}$
(5)
(1)
H_T
35
(70,150)
$\not\!\!E_T$
(7)
(4)
$N_{ttk}^{iso>0}$

“The BOX”



BNL Particle Physics Seminar

/W + ≥ N jets (N=2,3)

r this analysis the Z/W + N jet predictio are normalized to the Zee+ ❍ 2 jet CDF data using:

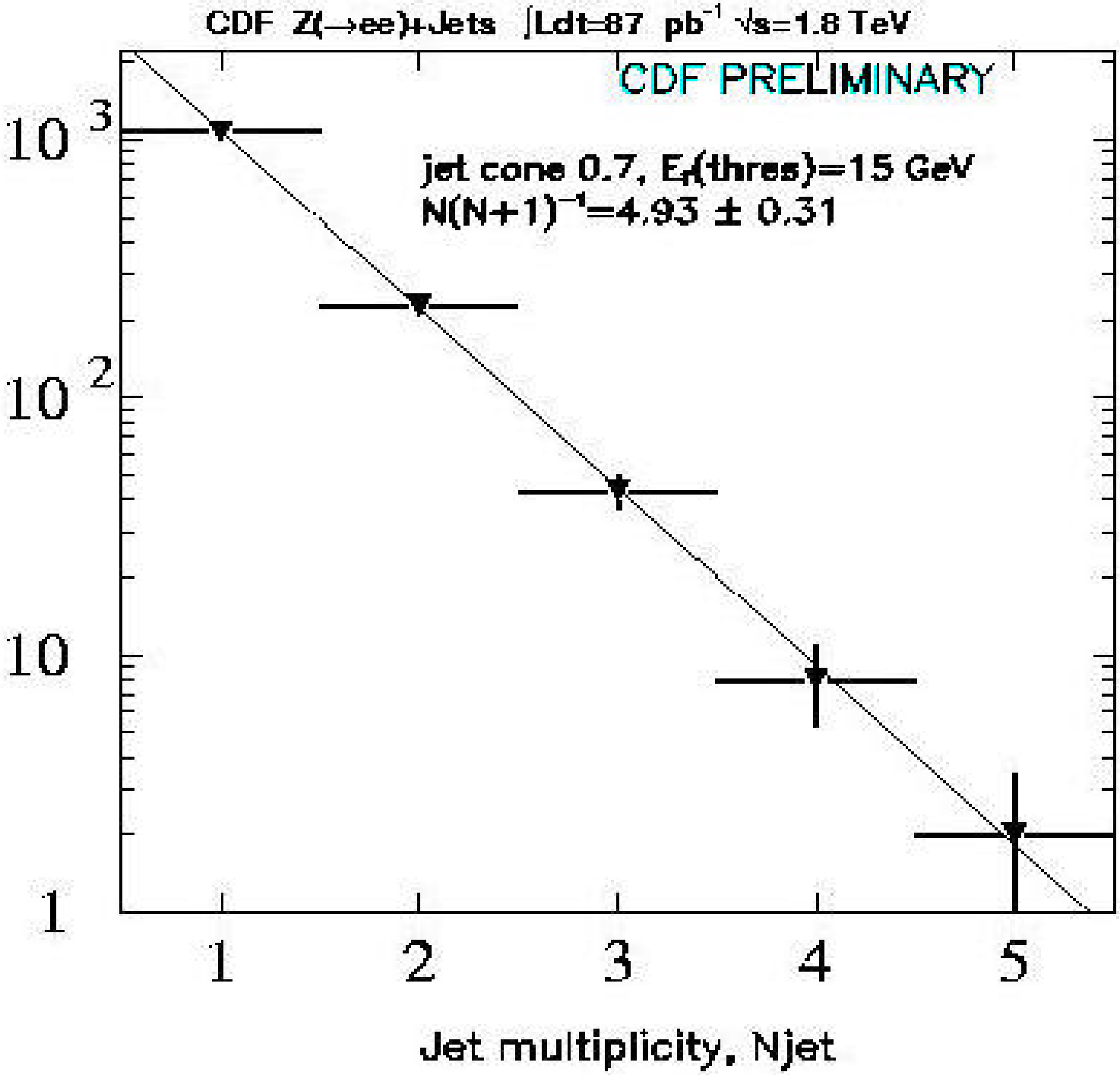
$= \frac{N}{N+1}\Big|^{DATA}$ to normalize the 3 jet

predictions using the 2 jet dat

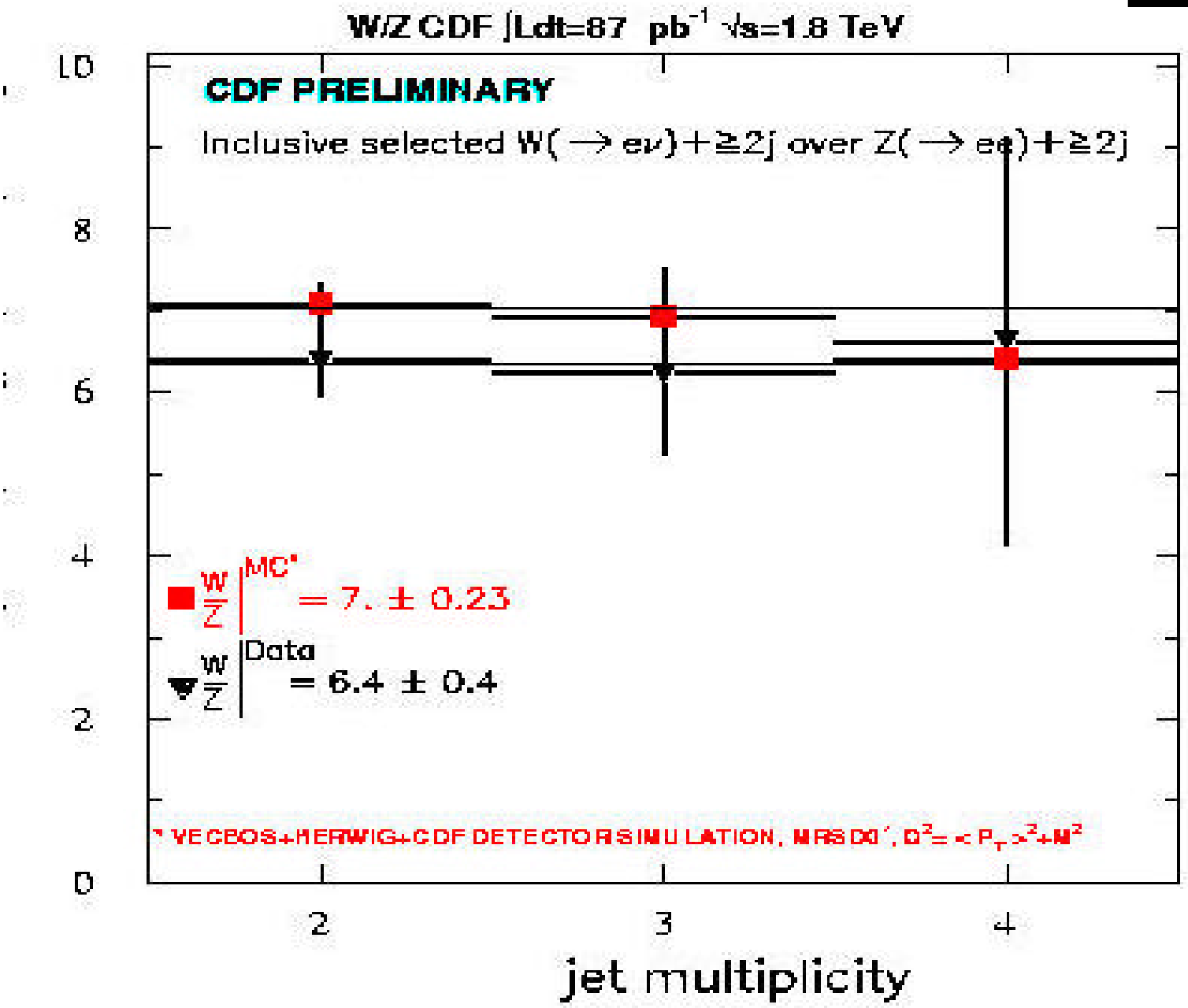
$' = \frac{W}{Z}\Big|^{MC}$ to normalize the W predictions

using the Z data

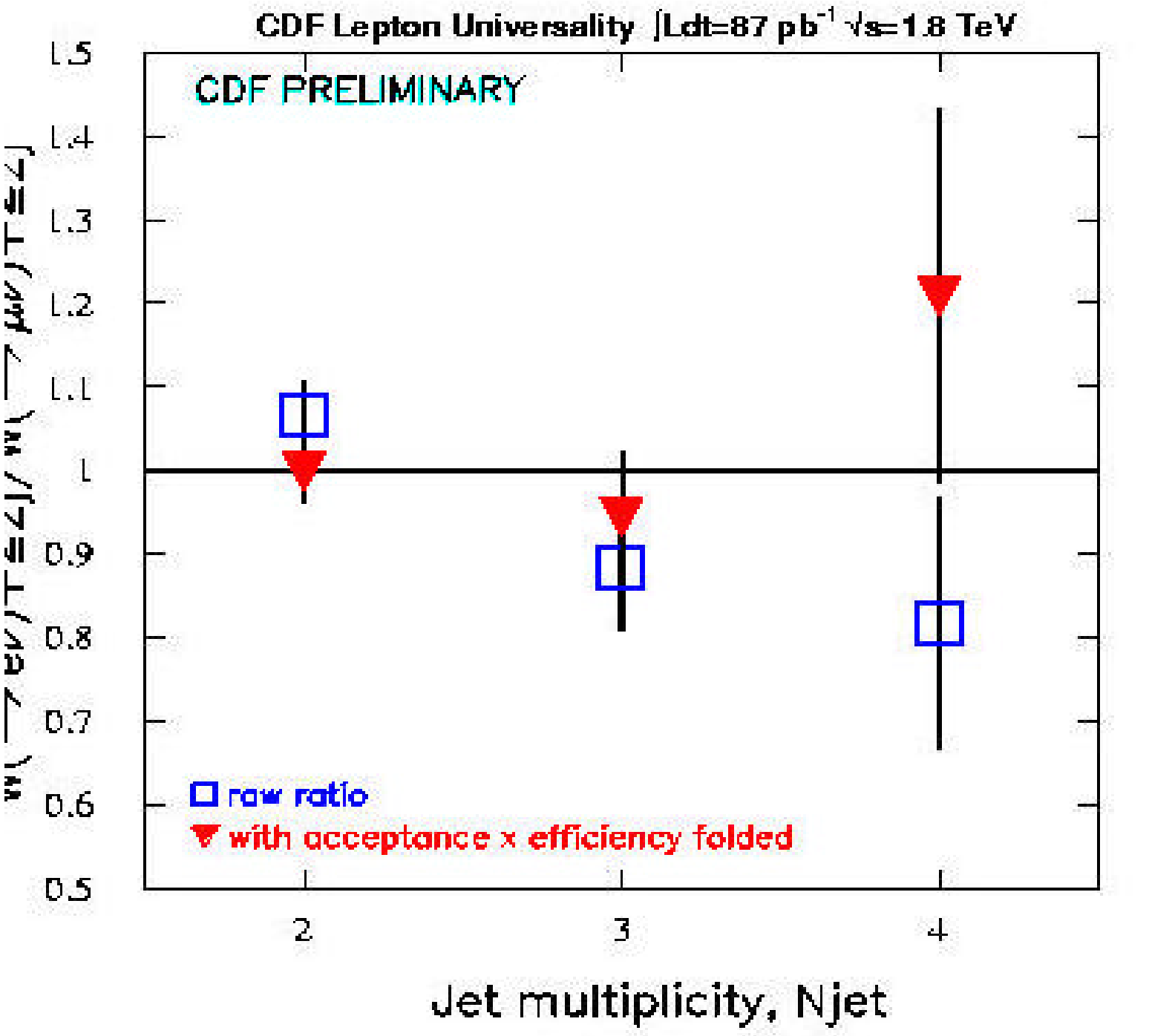
atios in the normalization: $Ld\sigma/dN_{jet}$



Ratios in the normalization:

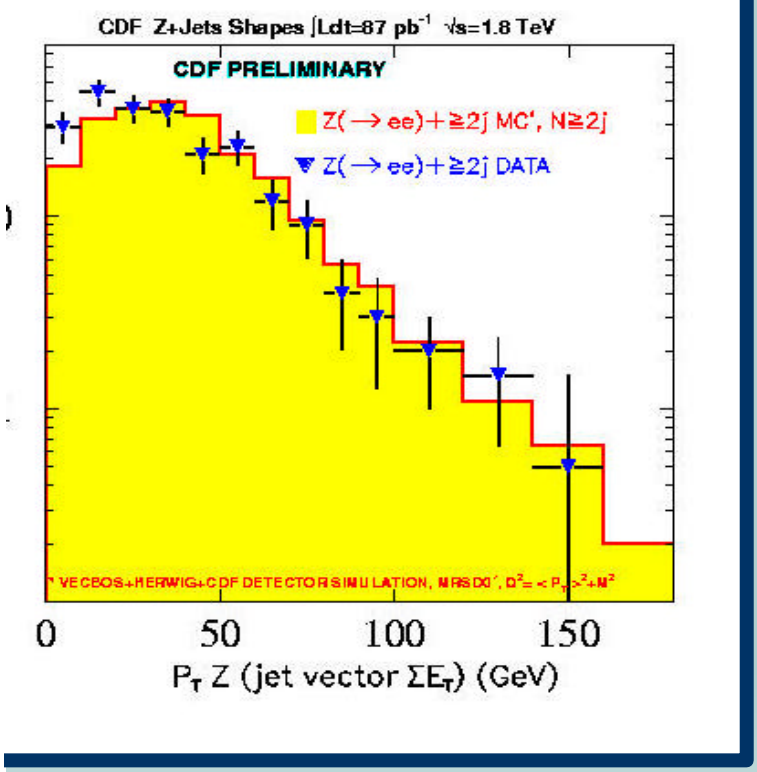


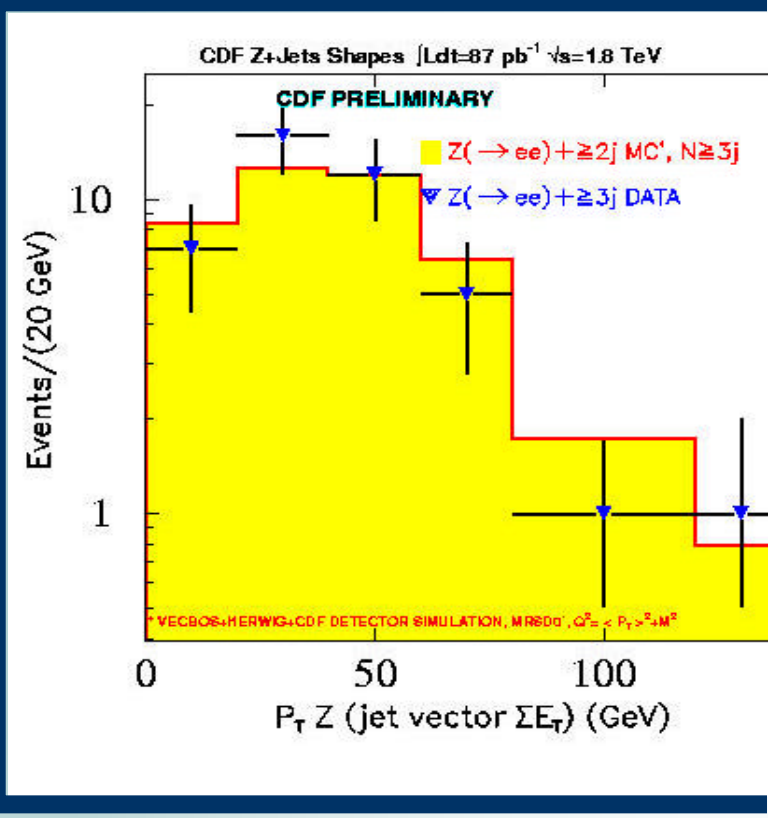
.epton Universality

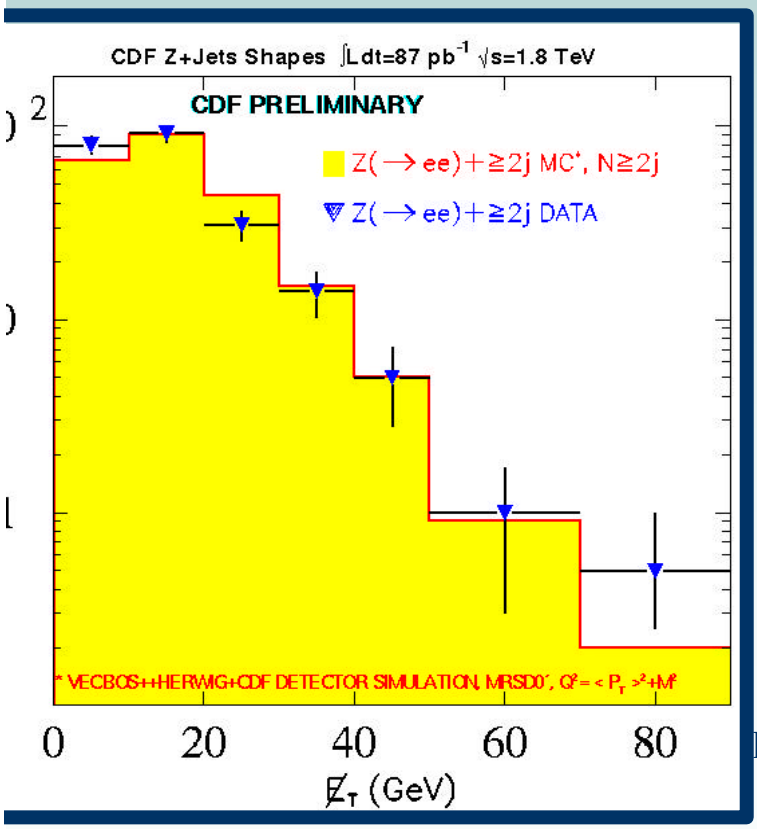


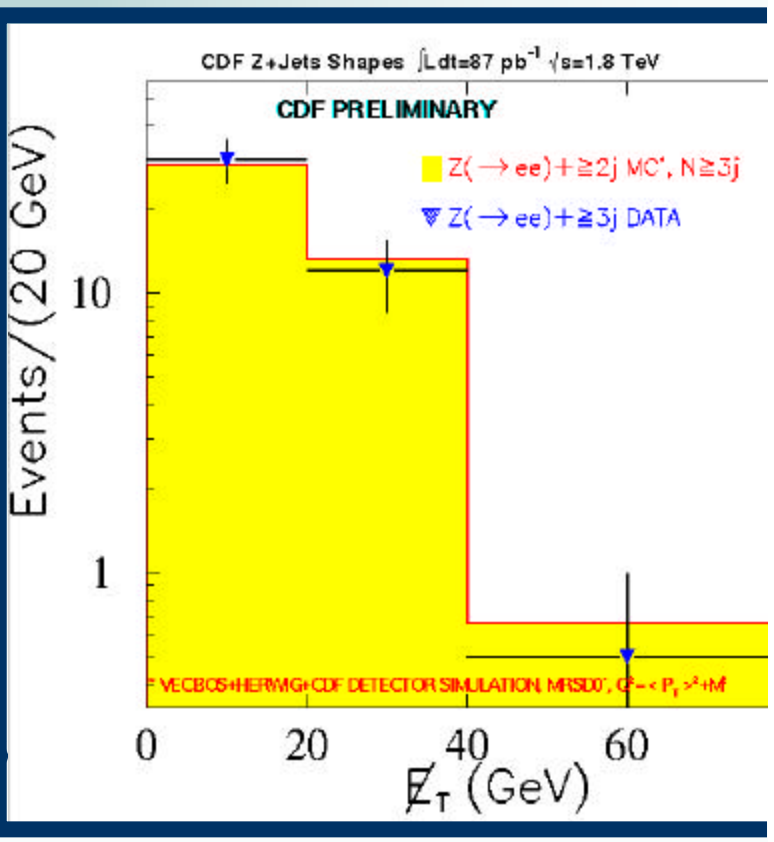
+ ≥ N jets (N=2,3)

HAPES



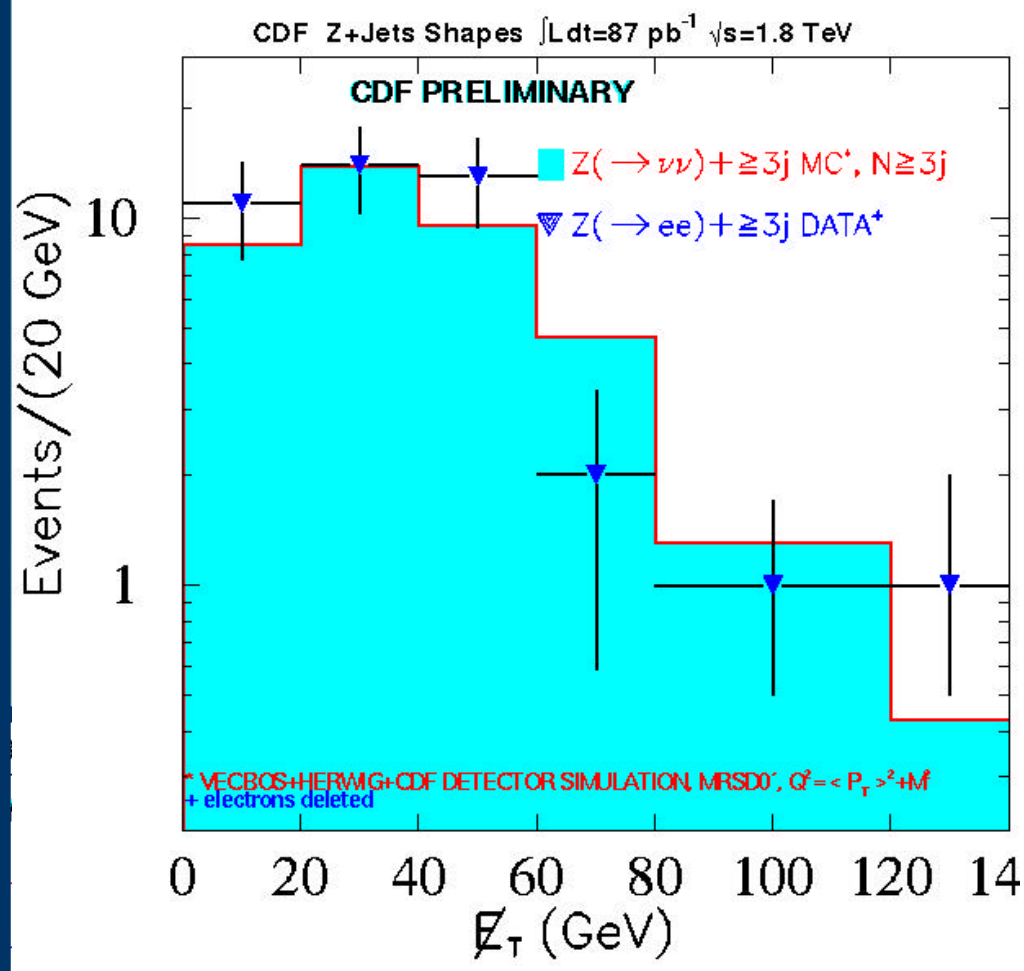


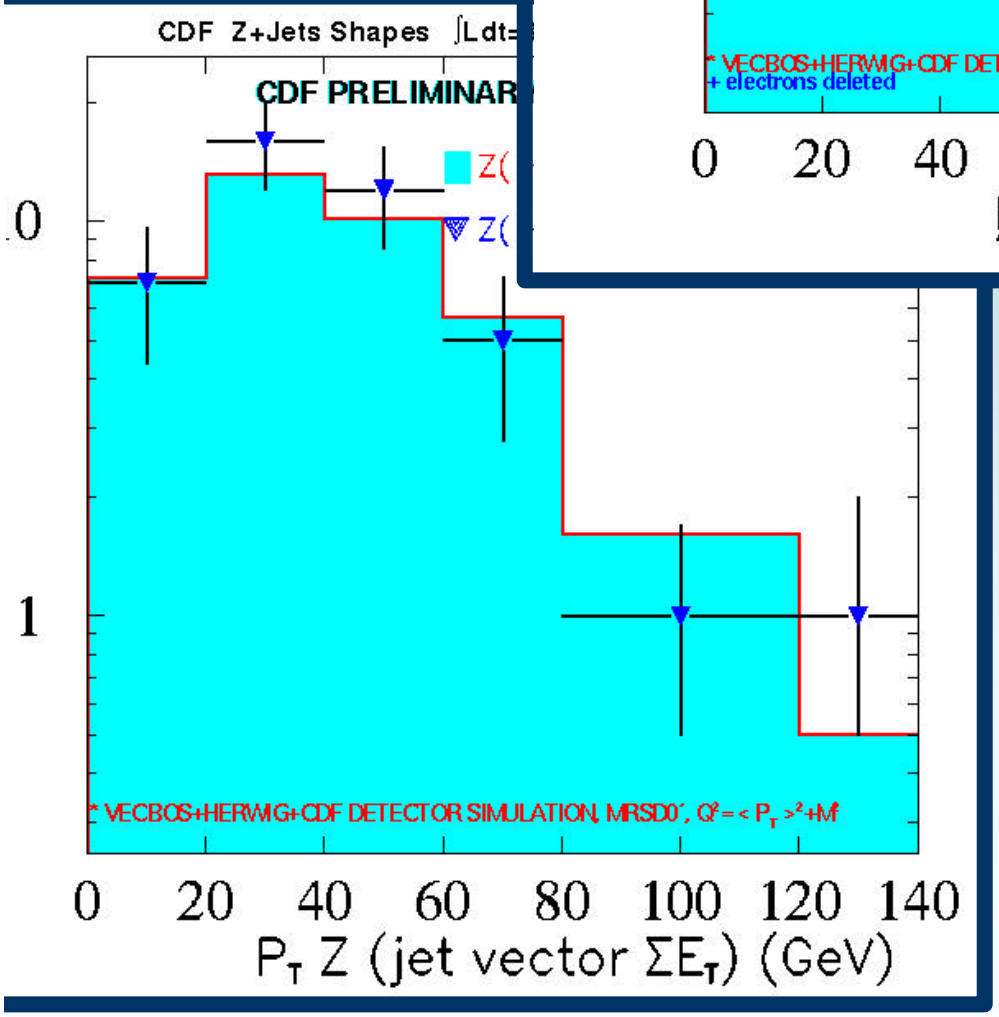




+ ≥ N jets (N=2,3)

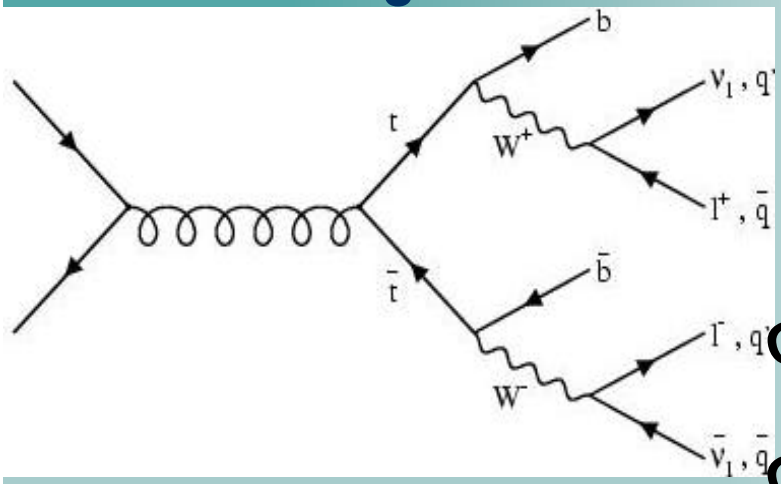
HAPES



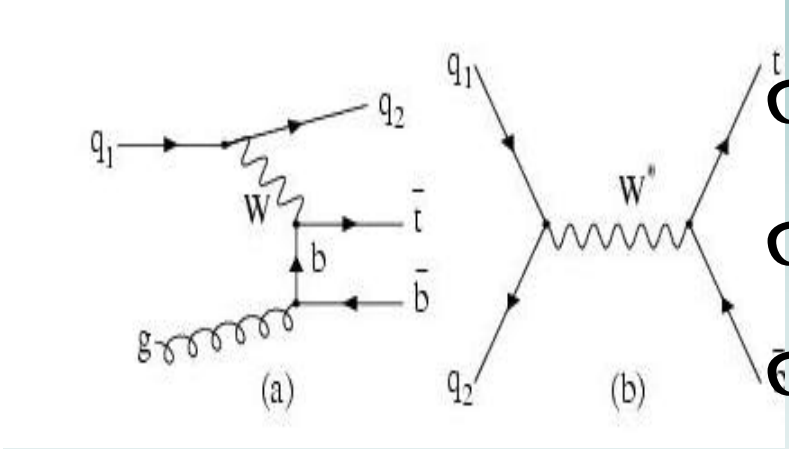


$t\bar{t}$, single top, diboson

MC samples Luminosity norm using theoretical cross sections



$\sigma_{t\bar{t}} = 5.06\,\text{pb} \pm 18\%$

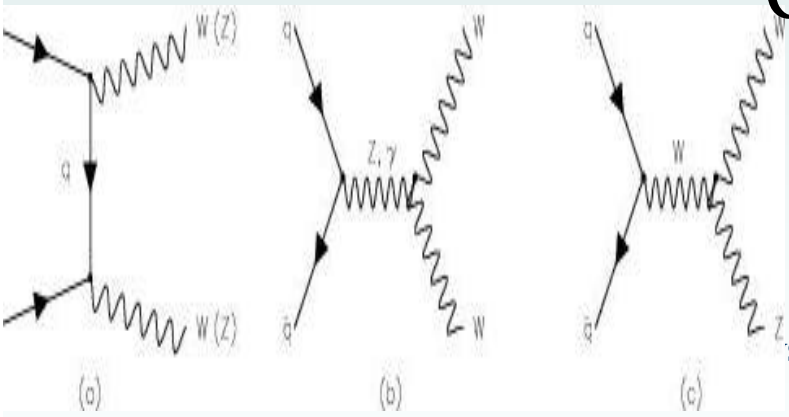


$\sigma_{W^* \to t\bar{b}} = 0.73\,\text{pb} \pm 9$

$\sigma_{WW} = 9.5\,\text{pb} \pm 7\%$

$\sigma_{WZ} = 2.6\,\text{pb} \pm 12\%$

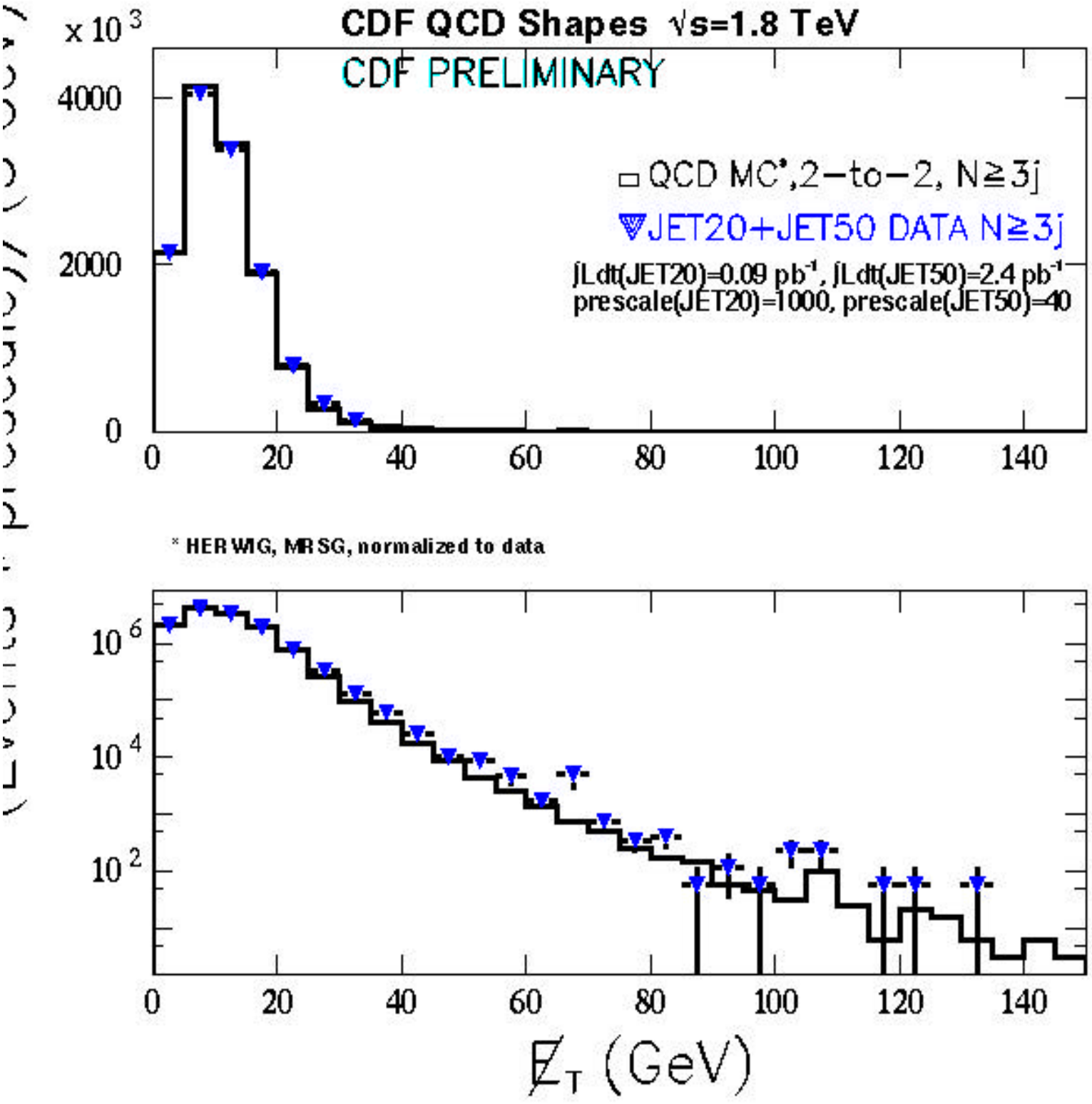
$\sigma_{ZZ} = 1.\,\text{pb} \pm 20\%$



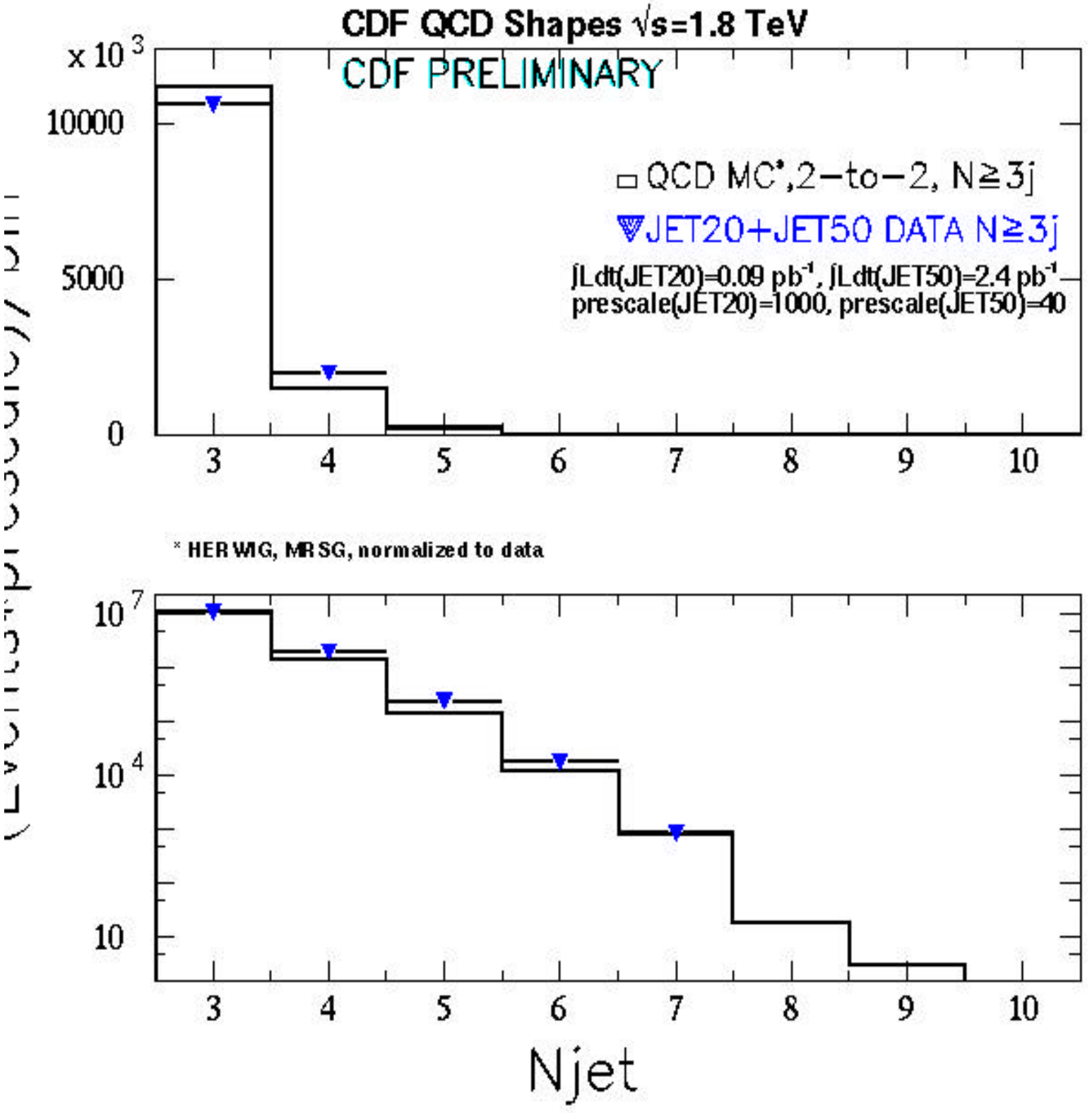
CD MULTIJET BACKGROUND

- Simulate 3-jet events for a very low reshold trigger (JET20) and a higher reshold trigger (JET50).
- NO Missing Energy required- use the hole Missing Energy spectrum.
- Fold in the trigger efficiencies measured the data.
- Merge samples and compare kinematic eshapes between data and QCD edictions.
- Measure the prescale factors and minosity of the JET data samples used.

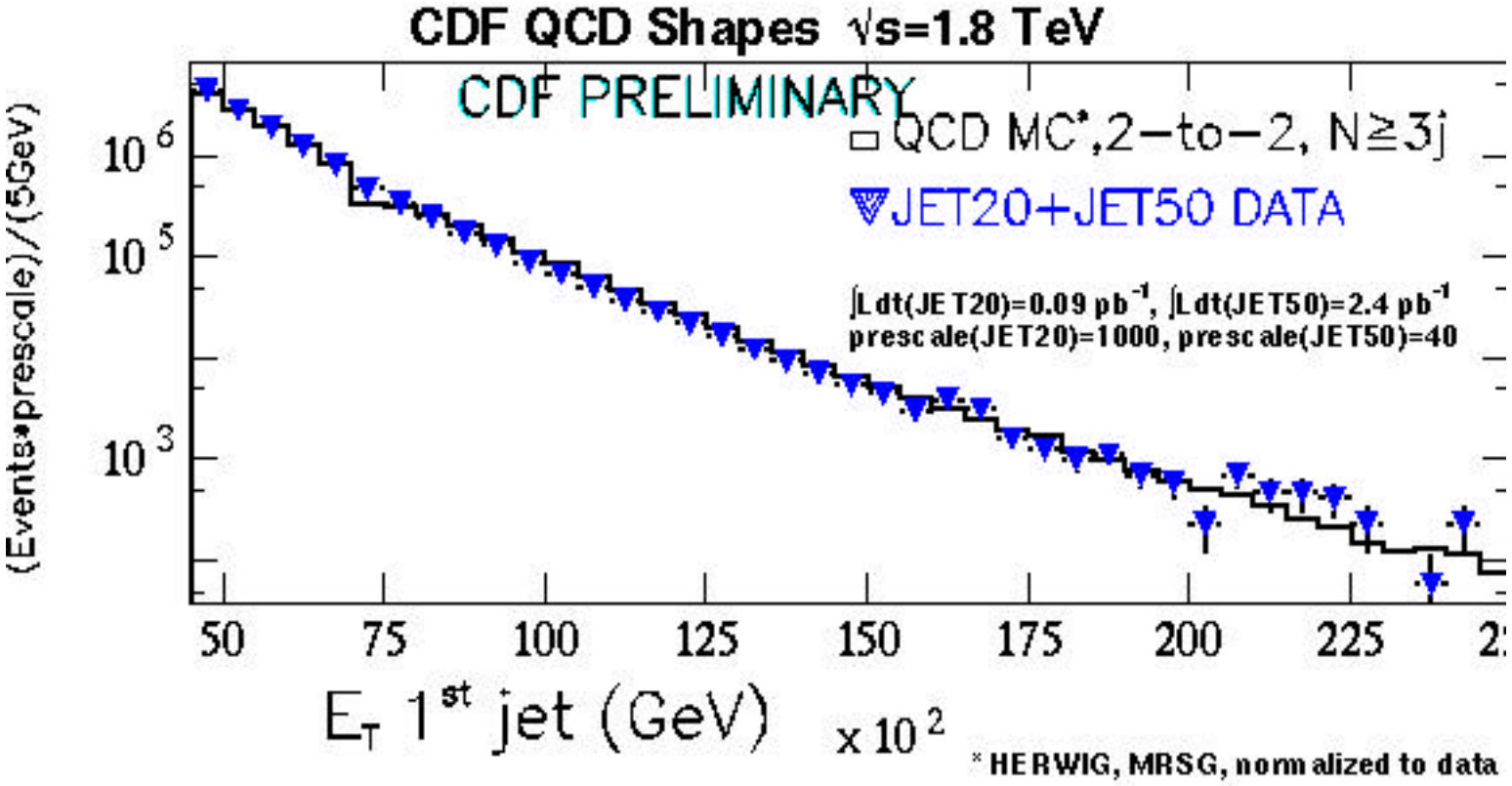
QCD MULTIJET BACKGROUND

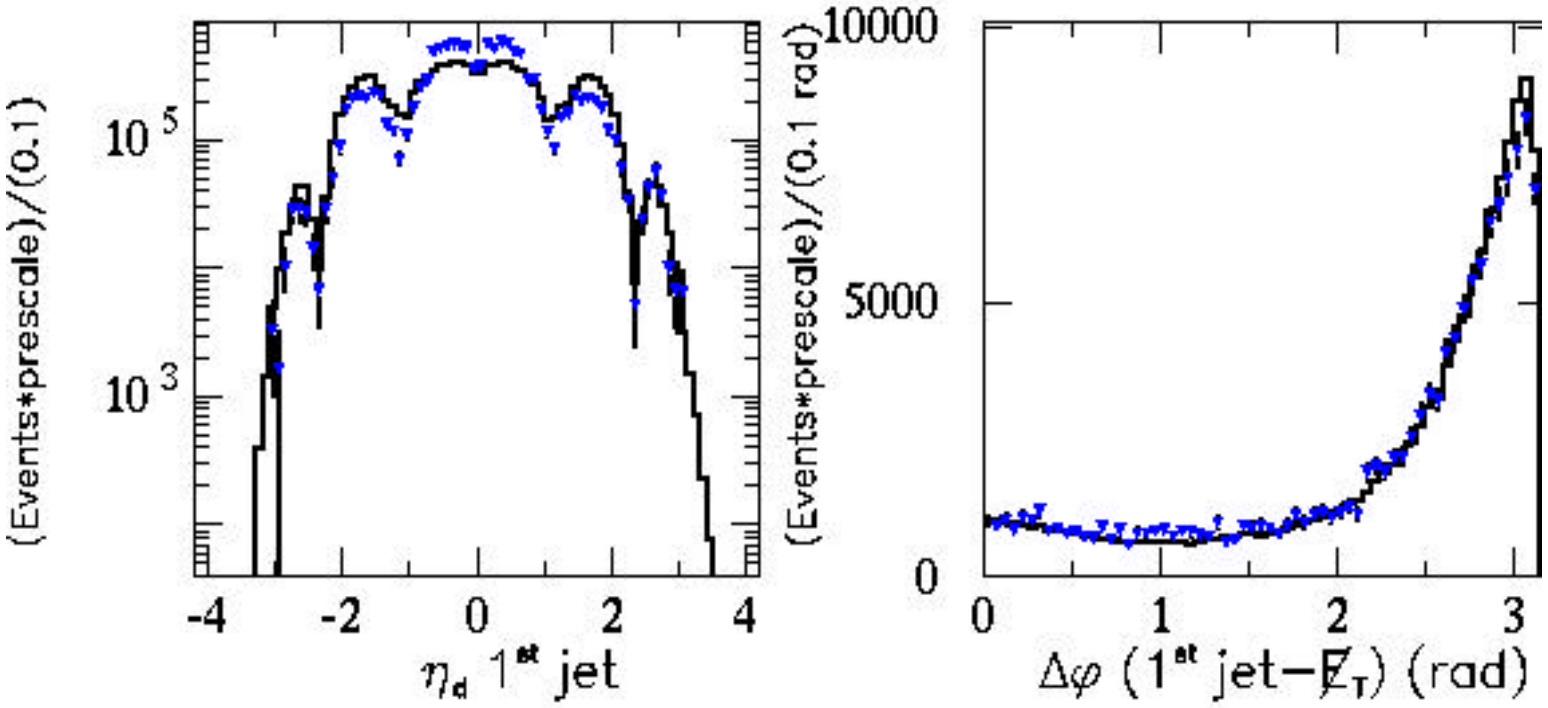


CD MULTIJET BACKGROUND

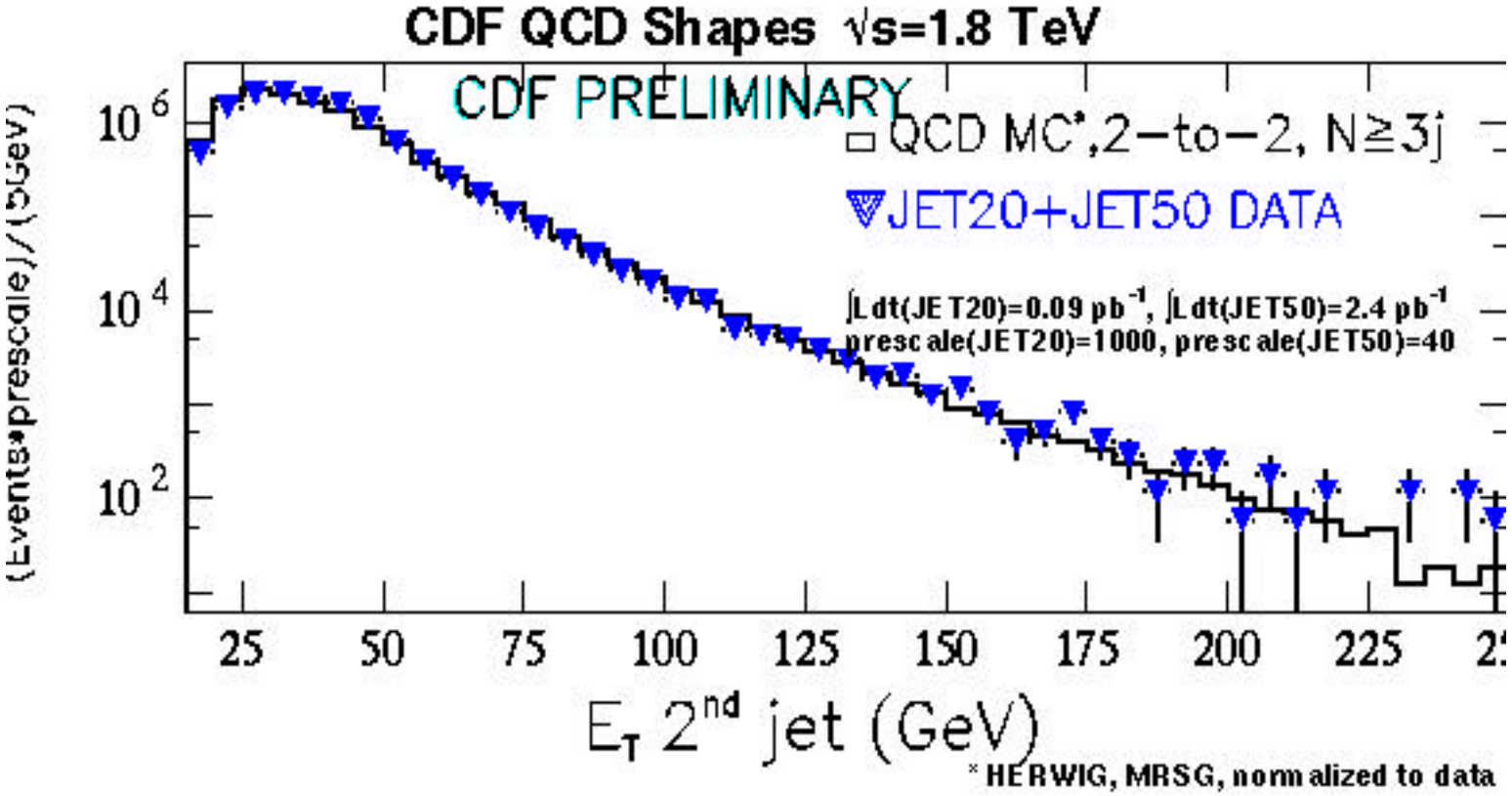


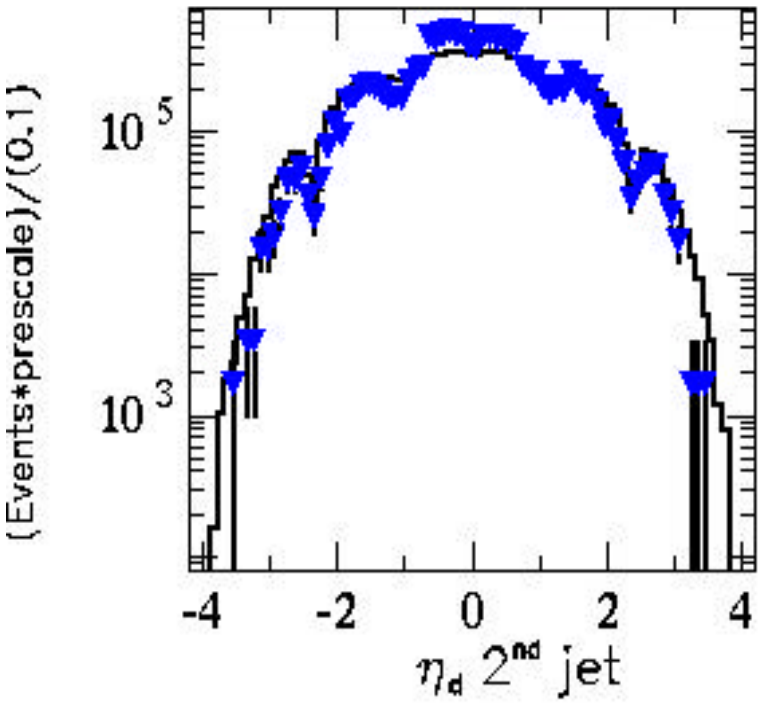
QCD MULTIJET BACKGROUND

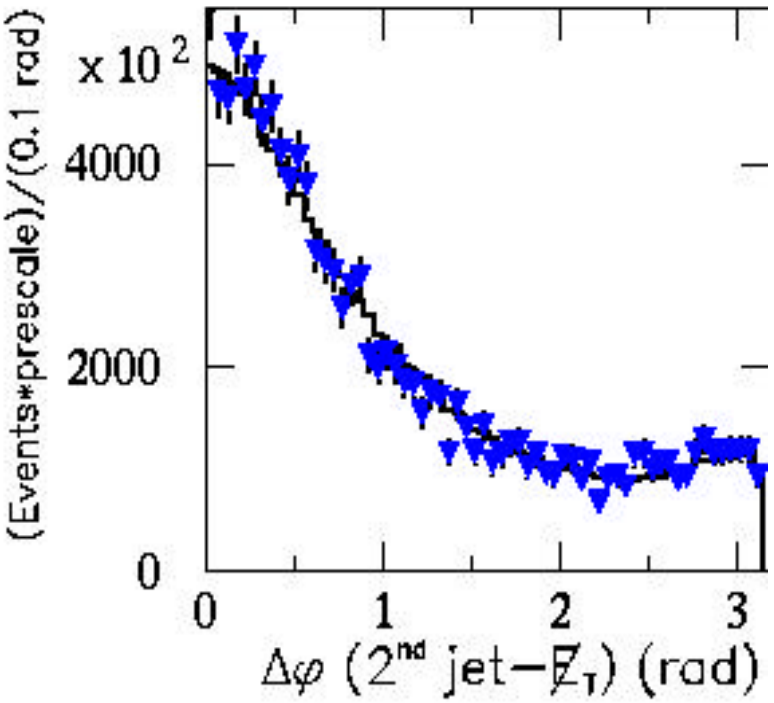




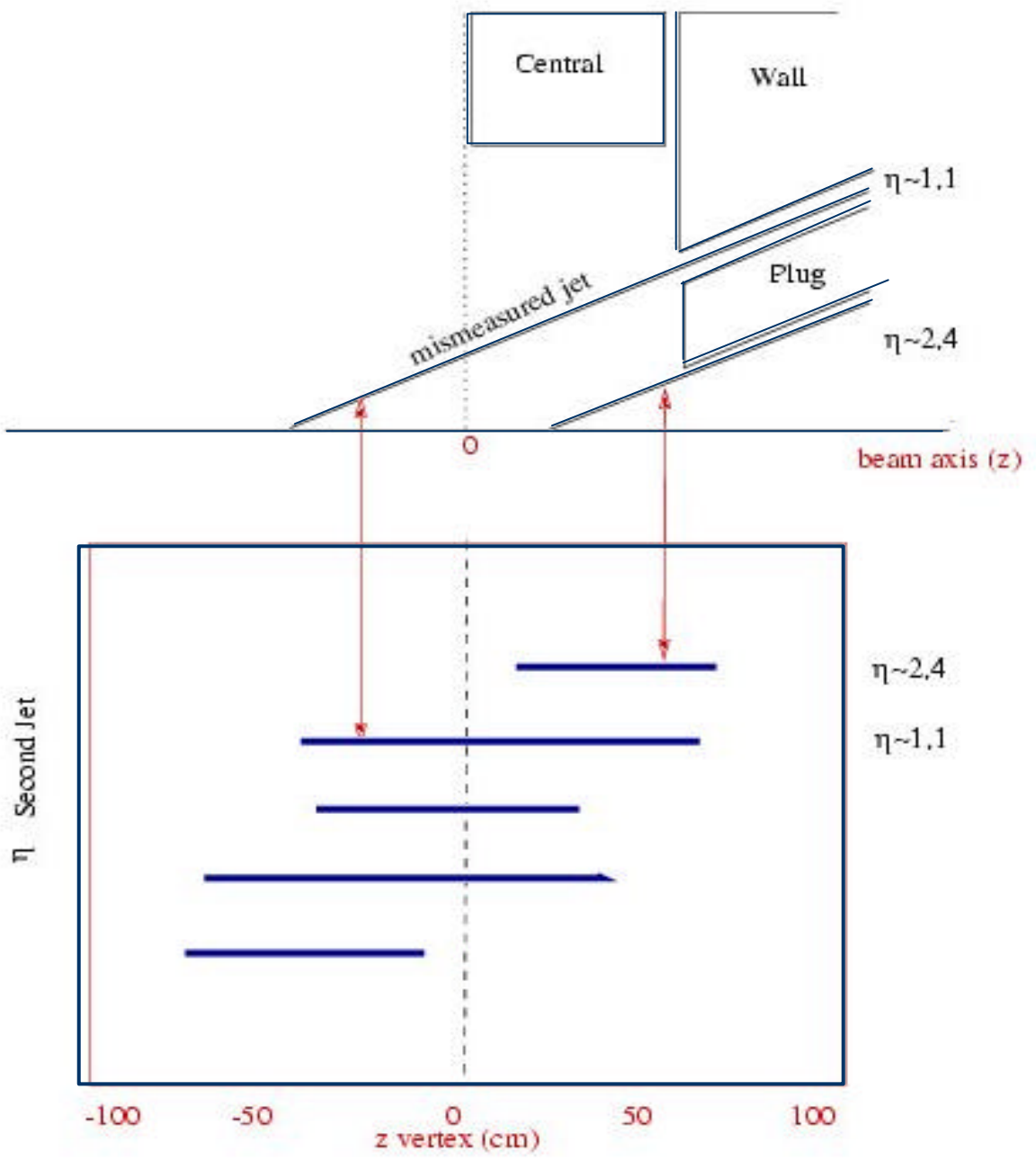
CD MULTIJET BACKGROUND



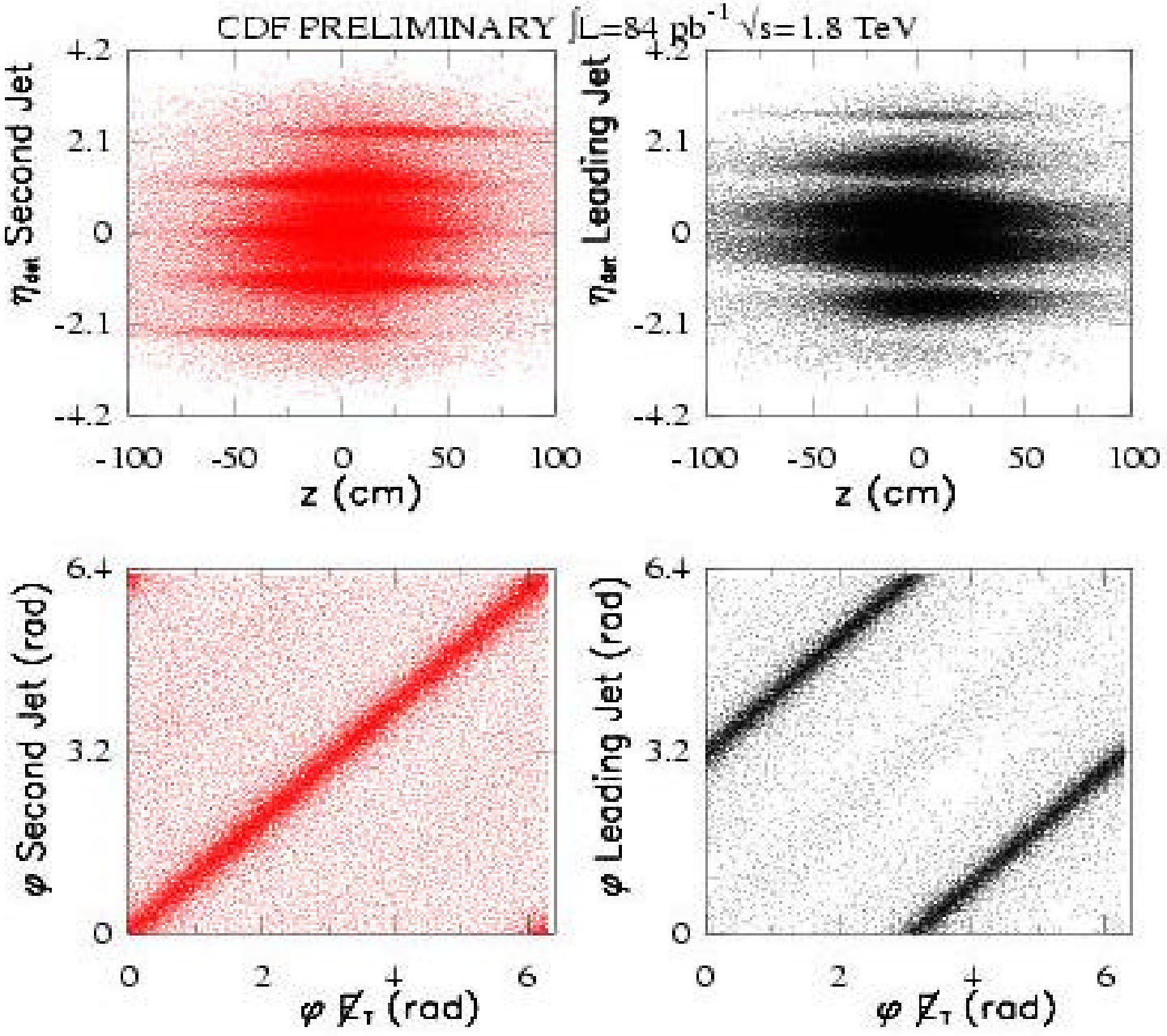




Missing Energy from QCD mismeasurements

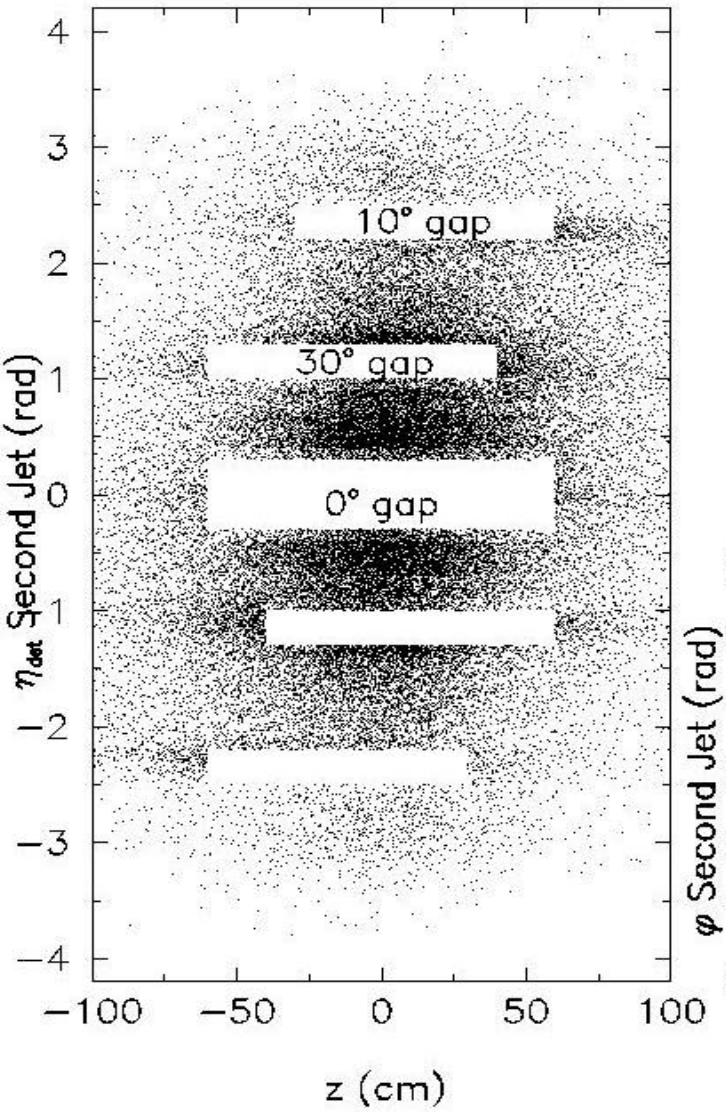


Missing Energy from QCD mismeasurements

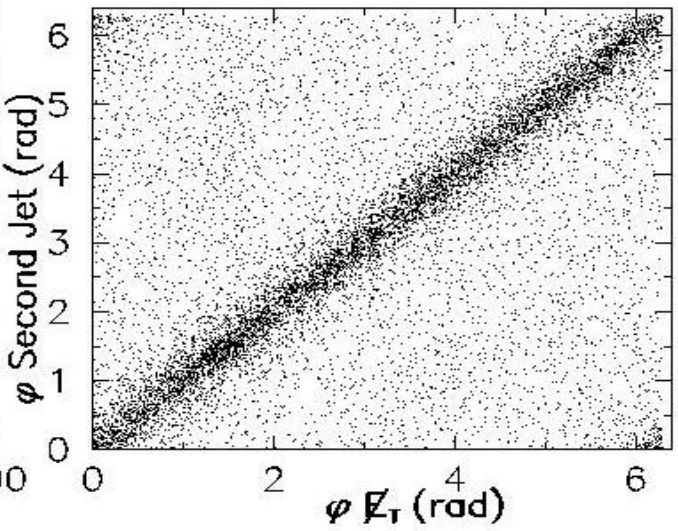


Missing Energy from QCD mismeasurements

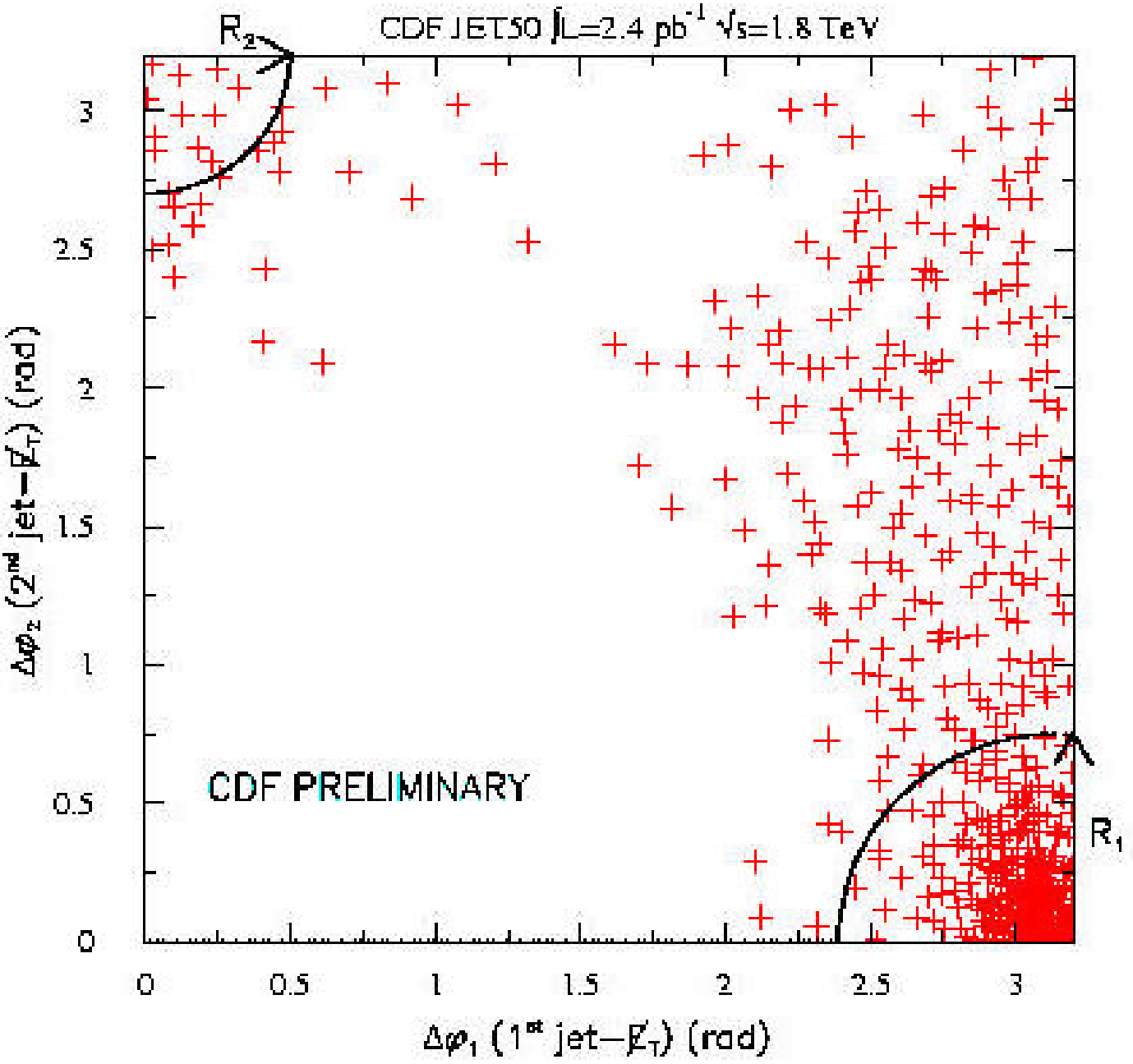
HERWIG(2-to-2)+CDF DETECTOR SIMULATION N≥ 3 Jets
JET FIDUCIALITY



If the η_{det} of the second jet is consistent with one of the gaps AND its φ is 0.5 radians or closer to the φ of the $\not\!\!E_T$ then the event is vetoed.

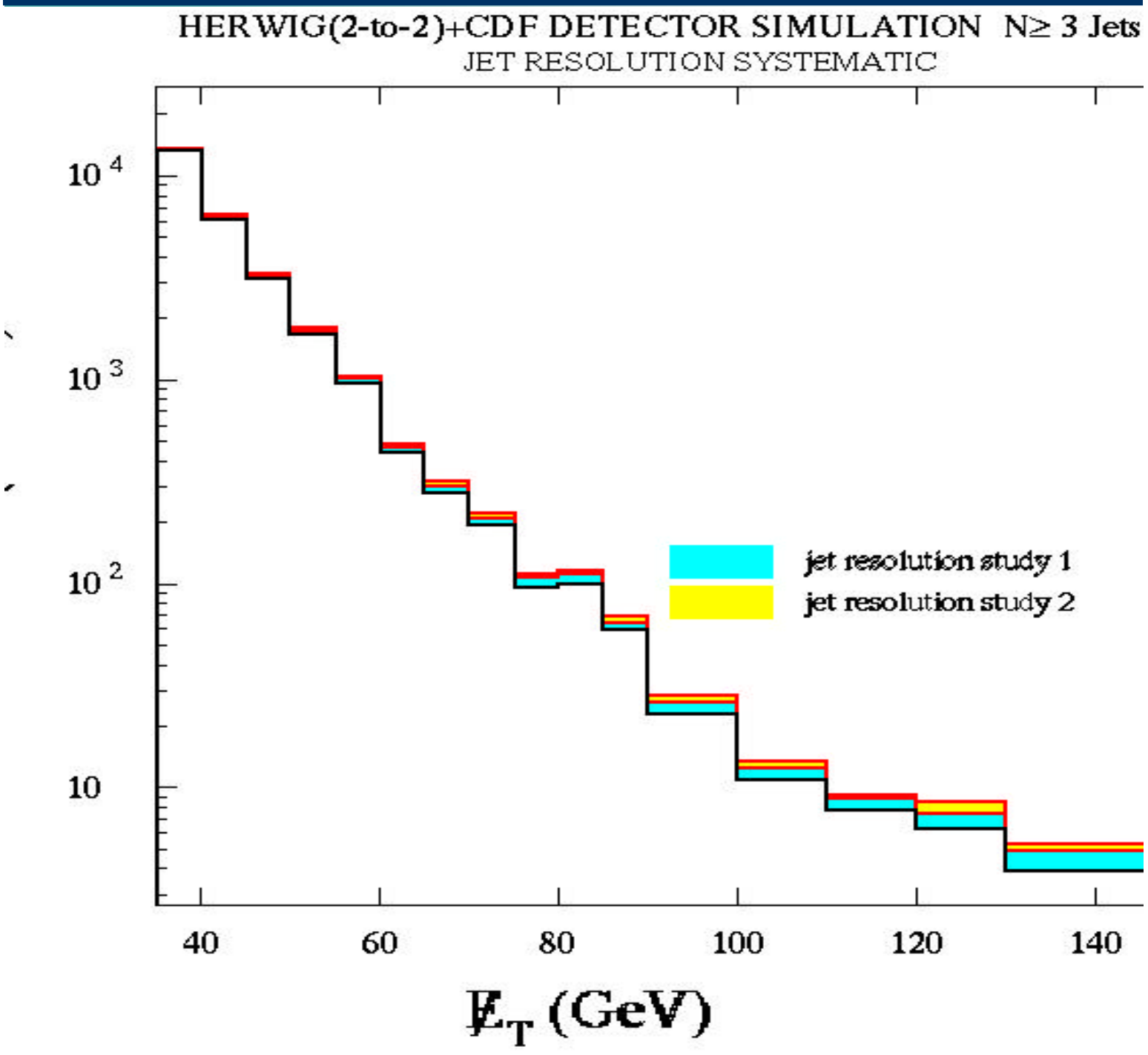


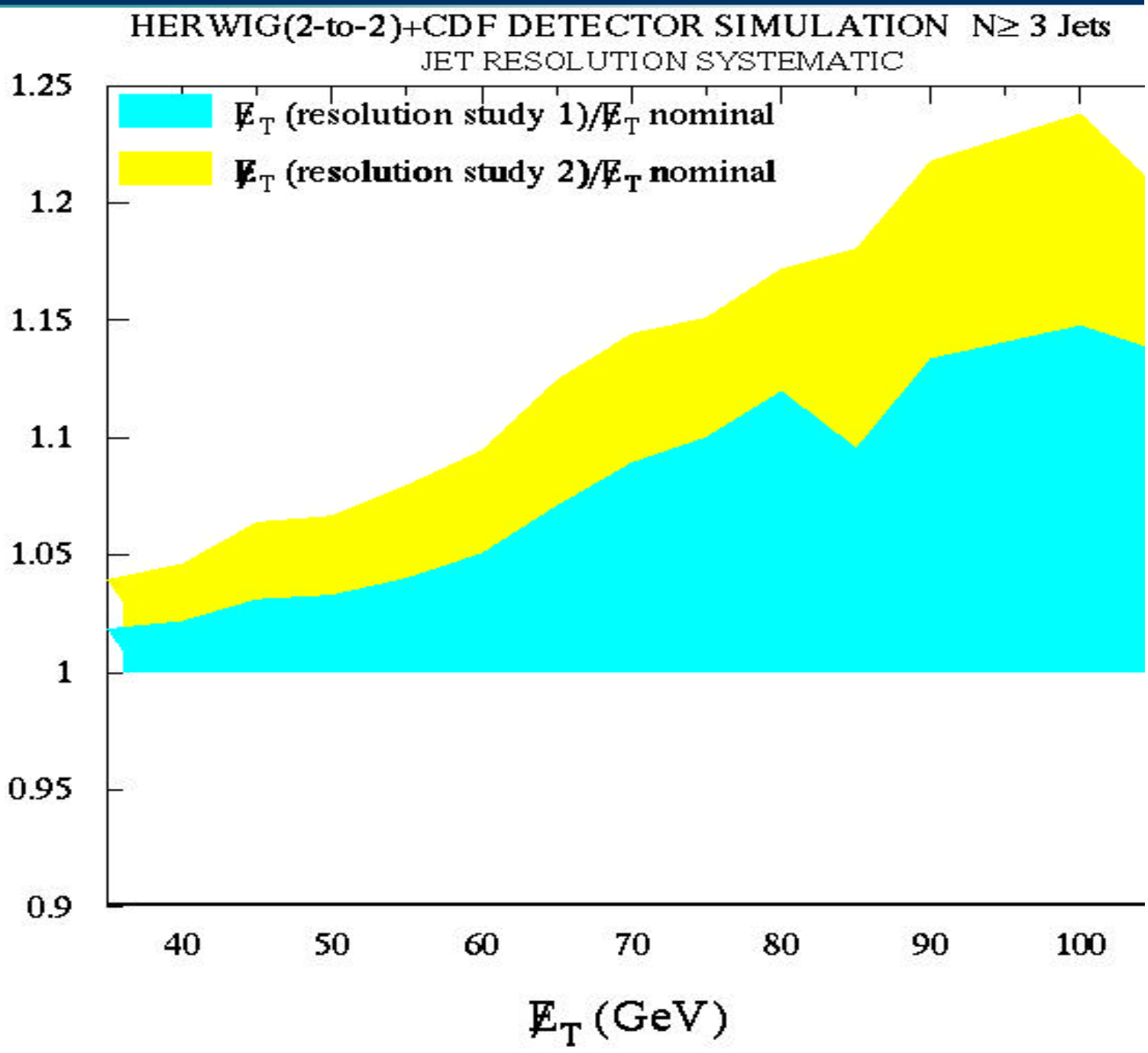
Missing Energy from QCD mismeasurements



$$R_1 = \sqrt{\delta\phi_1^2 - (\pi - \delta\phi_2)^2}, R_2 = \sqrt{\delta\phi_2^2 - (\pi - \delta\phi_1)^2}$$

COMMENTS ON THE QCD BACKGROUND




HERWIG(2-to-2)+CDF DETECTOR SIMULATION N≥ 3 Jets
JET RESOLUTION SYSTEMATIC
$\not\!\!E_T$ (resolution study 1)/$\not\!\!E_T$ nominal
$\not\!\!E_T$ (resolution study 2)/$\not\!\!E_T$ nominal
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
40
50
60
70
80
90
100
$\not\!\!E_T$ (GeV)

nalysis Path

Requirement	Number of Events passing
Pre-Selection and Bad Run veto	286728, (I)
$N_{jet} \geq 3$ (cone .7, $E_T \geq$ 15 GeV)	107509,(II)
Fiduciality	
fiducial 2nd,3rd jet	57011
2-D $\delta\phi$	23381
BOX data removed	
$E_T(1) \geq 70$GeV $E_T(2) \geq 30$GeV $\lvert\eta_d\rvert$(1 *or* 2 *or* 3) < 1.1	6435,(III)
EMF(1),EMF(2) ≤ 0.9	6013
L2 trigger	4679
$\delta\phi_{rmin} \geq 0.3$	2737

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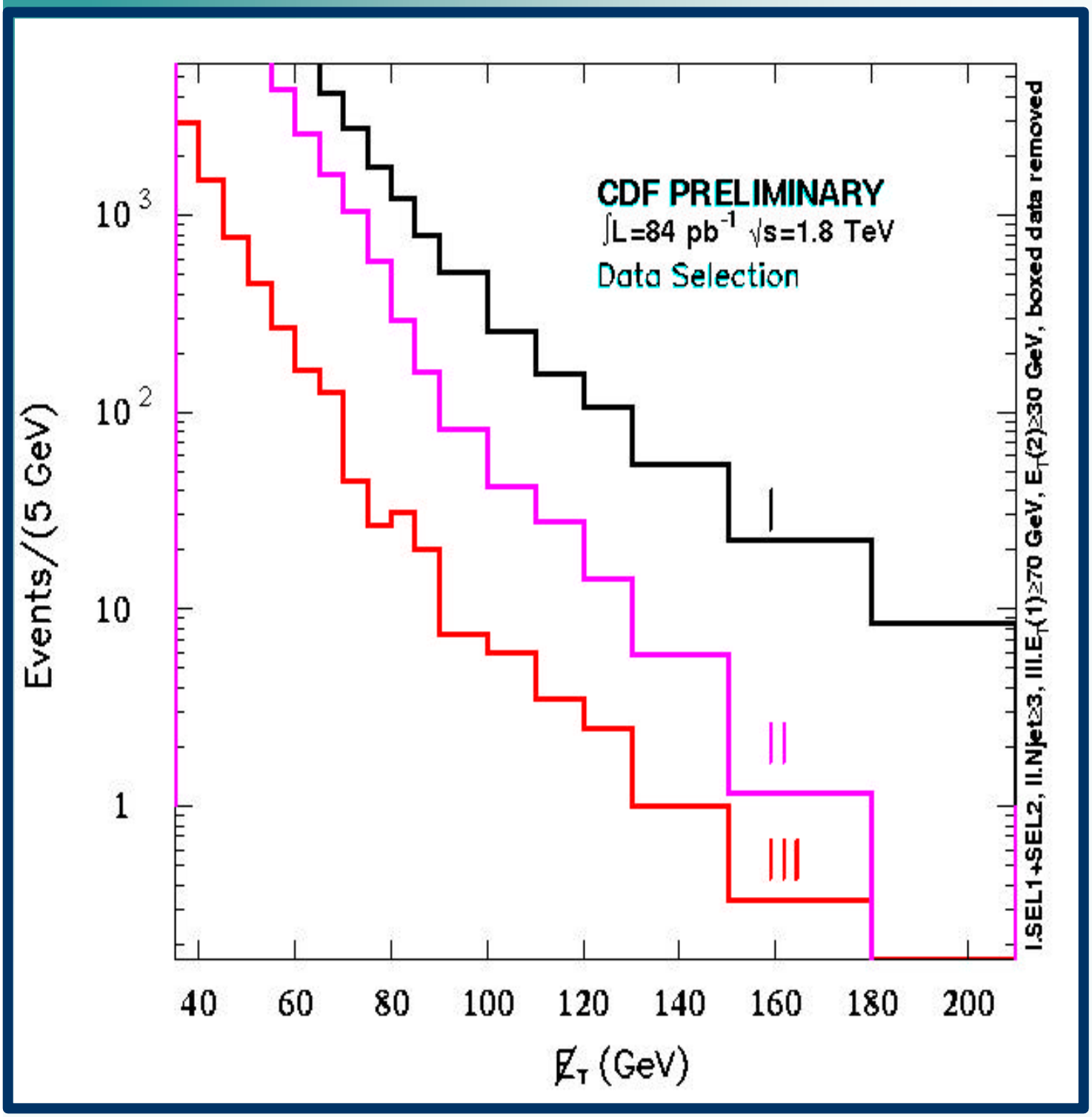
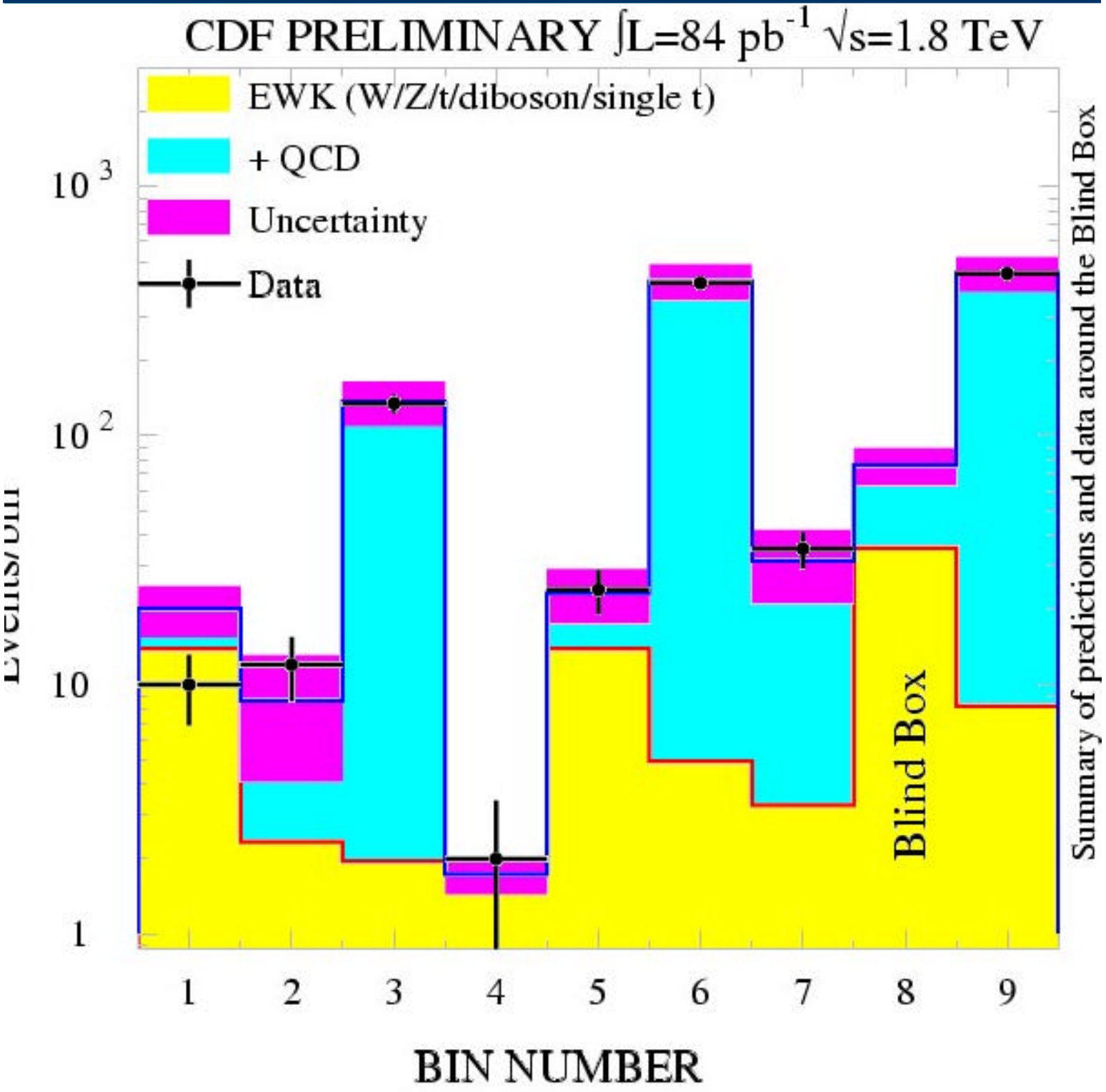
nalysis Path



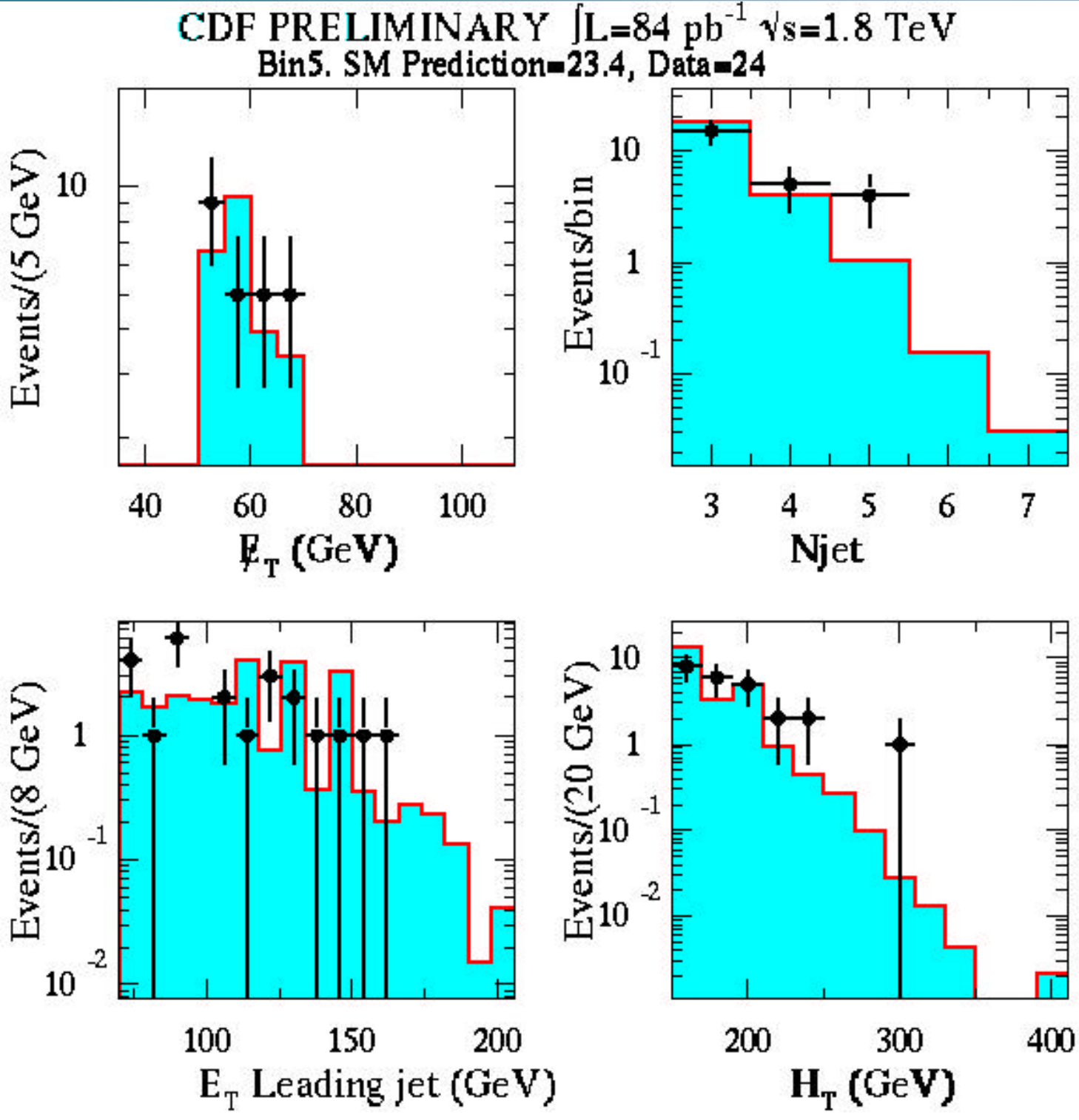
mparisons SM predictions-Data
ound the Blind Box

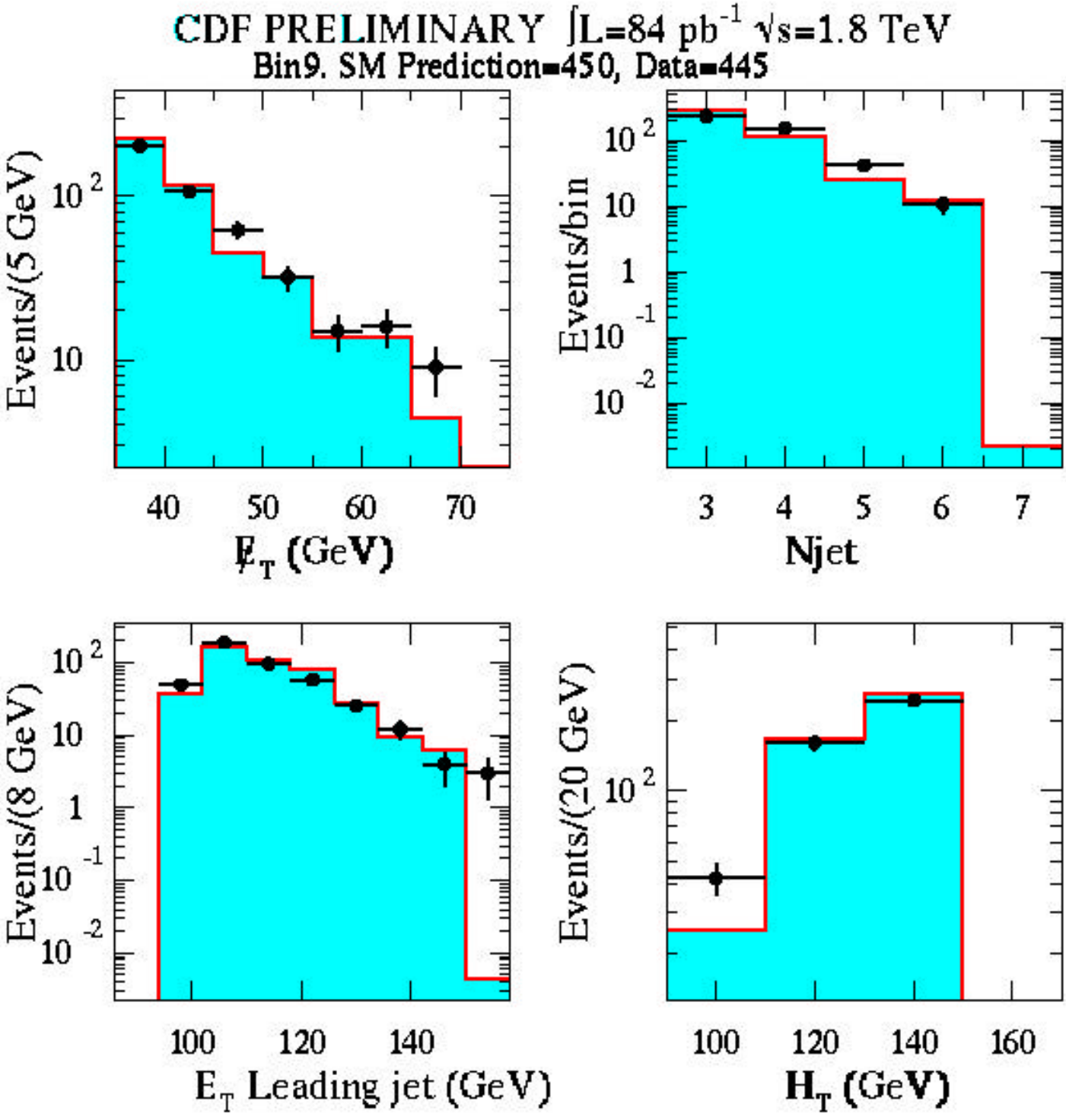
	Description	EWK	QCD	All	Dat
1	$\not\!\!E_T \geq 70, H_T \geq 150, N_{trk}^{iso} > 0$	13.9	6.26	20.2±4.7	10
2	$\not\!\!E_T \geq 70, H_T < 150, N_{trk}^{iso} = 0$	2.3	6.26	8.6±4.5	12
3	$35 < \not\!\!E_T < 70, H_T > 150, N_{trk}^{iso} = 0$	1.95	134.6	136.5±27.8	134
4	$\not\!\!E_T > 70, H_T < 150, N_{trk}^{iso} > 0$	1.73	0	1.73±0.3	2
5	$35 < \not\!\!E_T < 70, H_T > 150, N_{trk}^{iso} > 0$	13.95	9.39	23.34±5.7	24
6	$35 < \not\!\!E_T < 70, H_T < 150, N_{trk}^{iso} = 0$	4.9	413.16	418.1±68.8	41(
7	$35 < \not\!\!E_T < 70, H_T < 150, N_{trk}^{iso} > 0$	3.3	28.17	31.4±10.2	35
3	$\not\!\!E_T > 70, H_T > 150, N_{trk}^{iso} = 0$	35.3	40.69	76.02±12.8	?
9	$35 < \not\!\!E_T < 70, H_T < 150$	8.2	441.3	449.5±72	445

omparisons SM predictions-Data ound the Blind Box

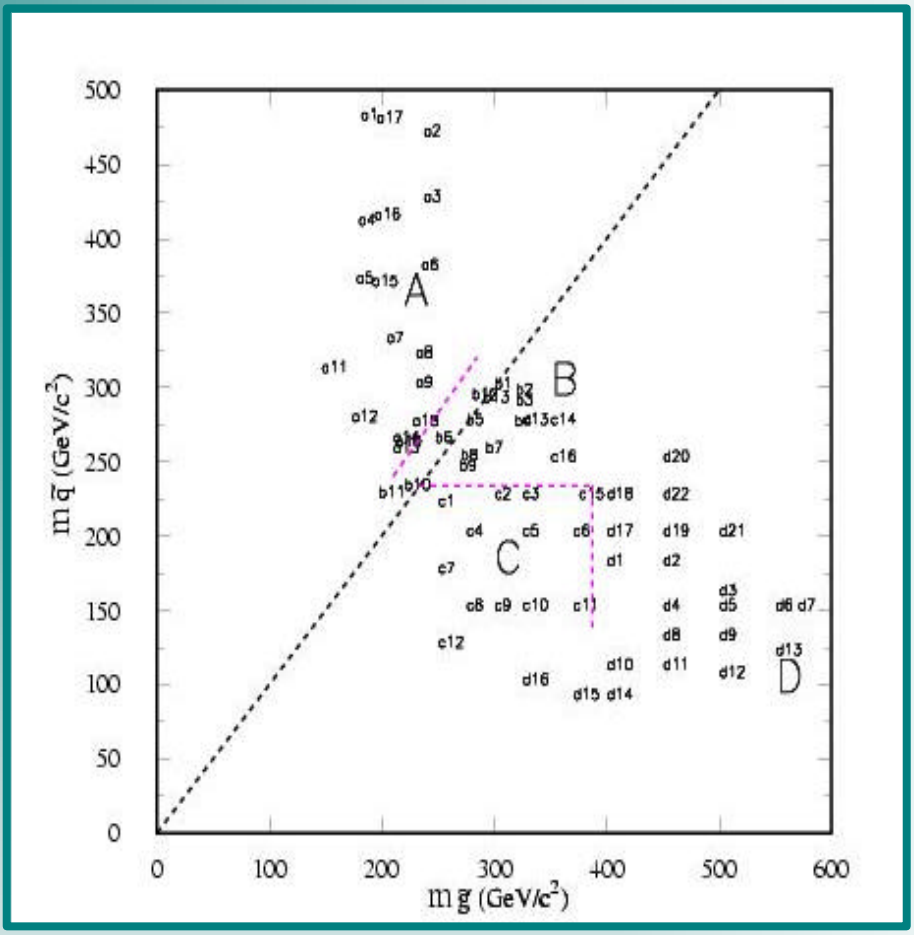


HAPES AROUND THE BOX




CDF PRELIMINARY ∫L=84 pb^{-1} √s=1.8 TeV
Bin9. SM Prediction=450, Data=445
Events/(5 GeV)
$\not\!\!E_T$ (GeV)
Events/bin
Njet
Events/(8 GeV)
E_T Leading jet (GeV)
Events/(20 GeV)
H_T (GeV)

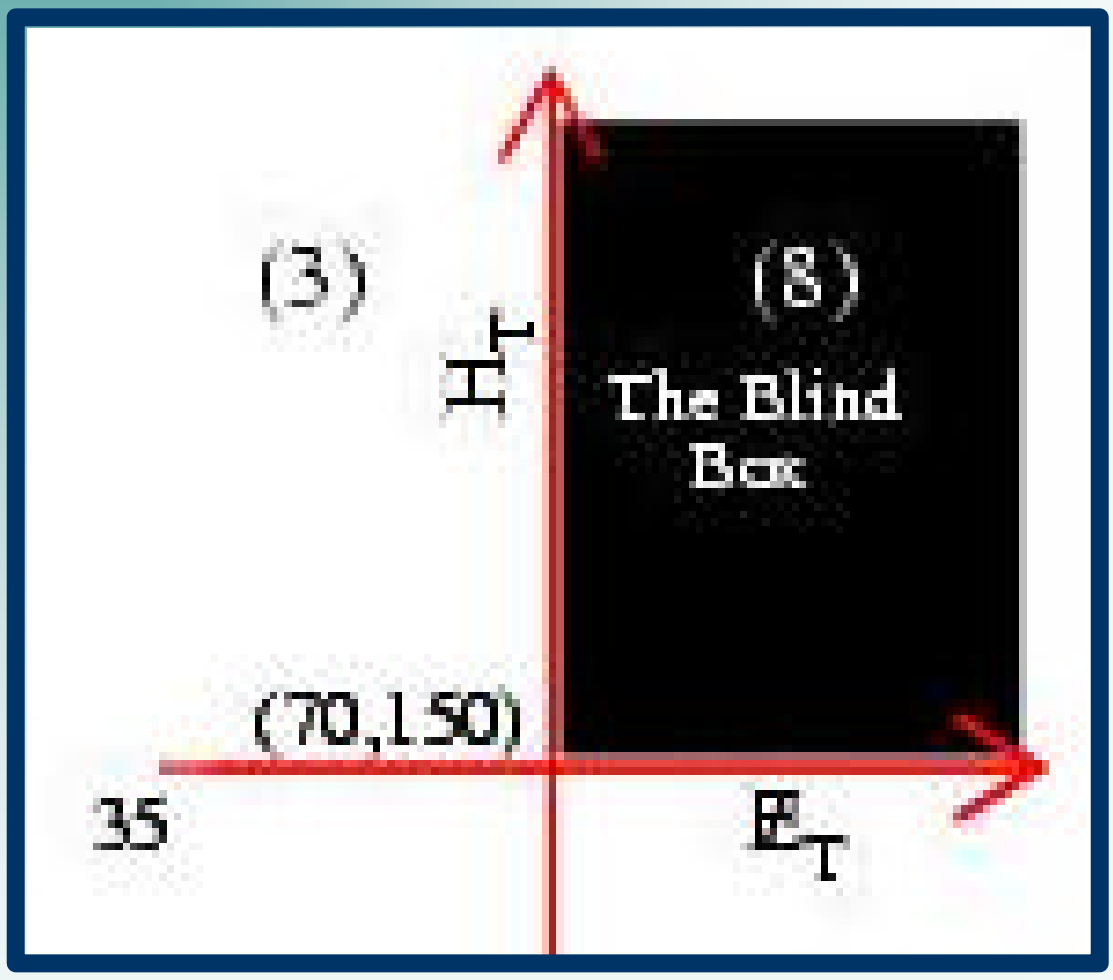
OPTIMAZATION IN SUSY SPACE



Regions	$\not{E}_T$, H_T(GeV)	Standard Model predictio
A/D	90,160	32.7±6.7
B	110,230	3.7±.5
C	110,170	10.6±1

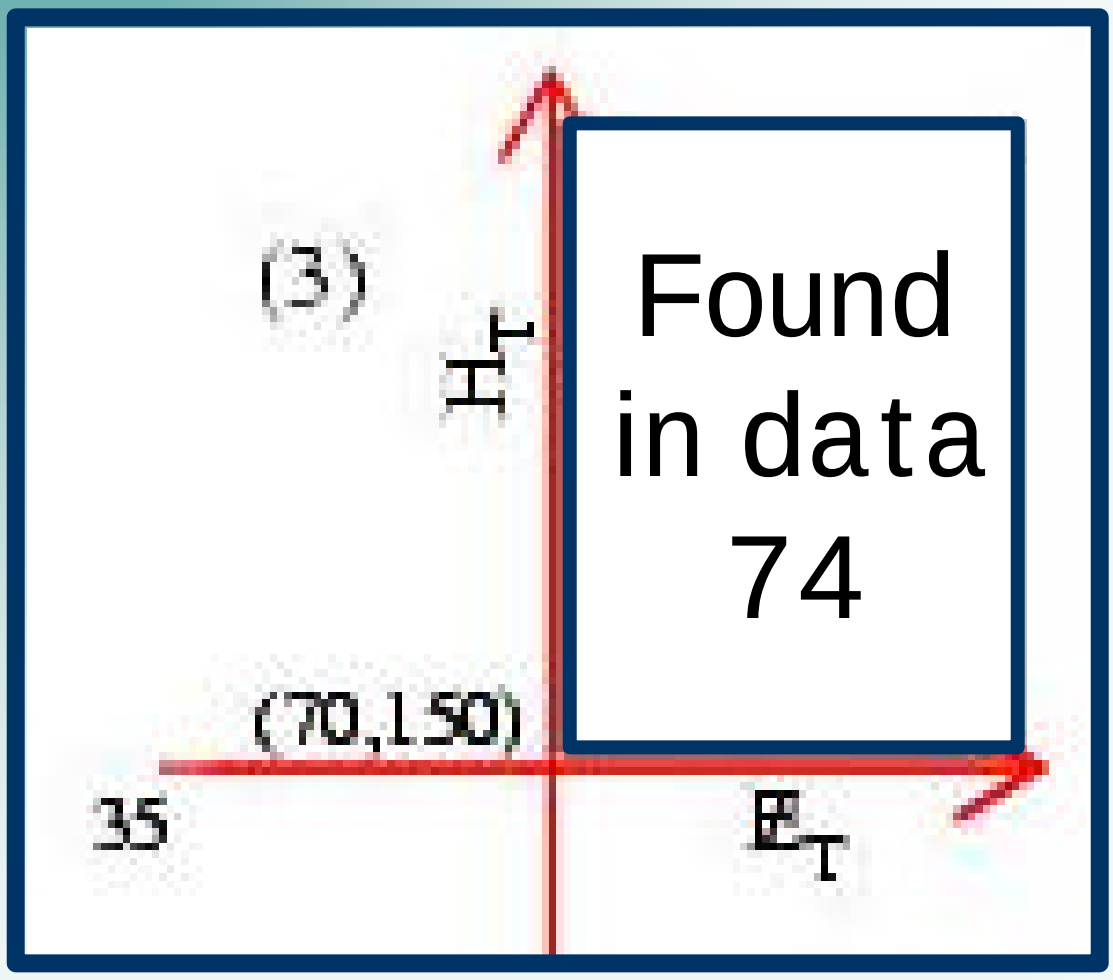
"The BOX"

The Box: SM Expected 76 1

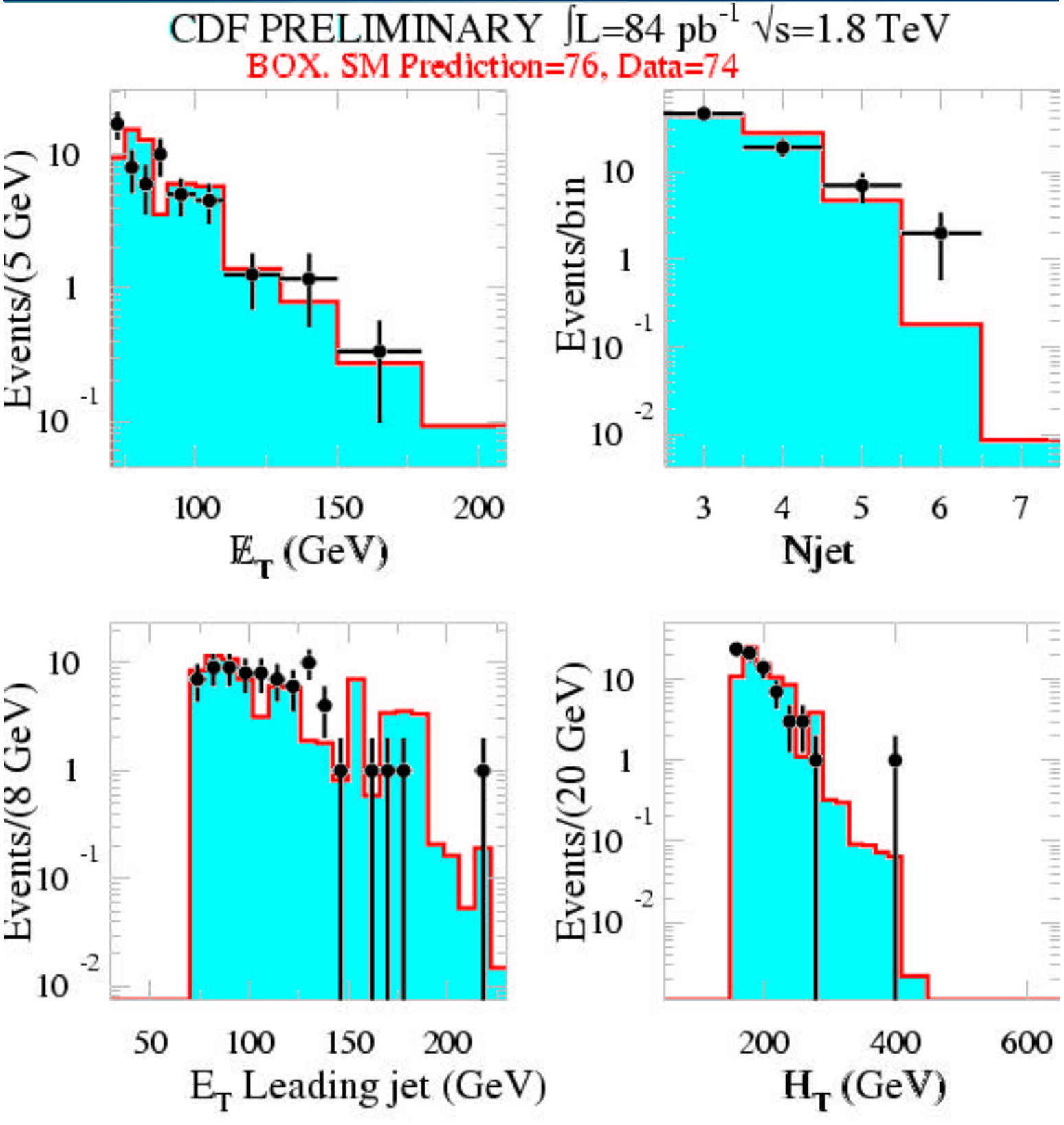


"The BOX"

The Box: SM Expected 76 1

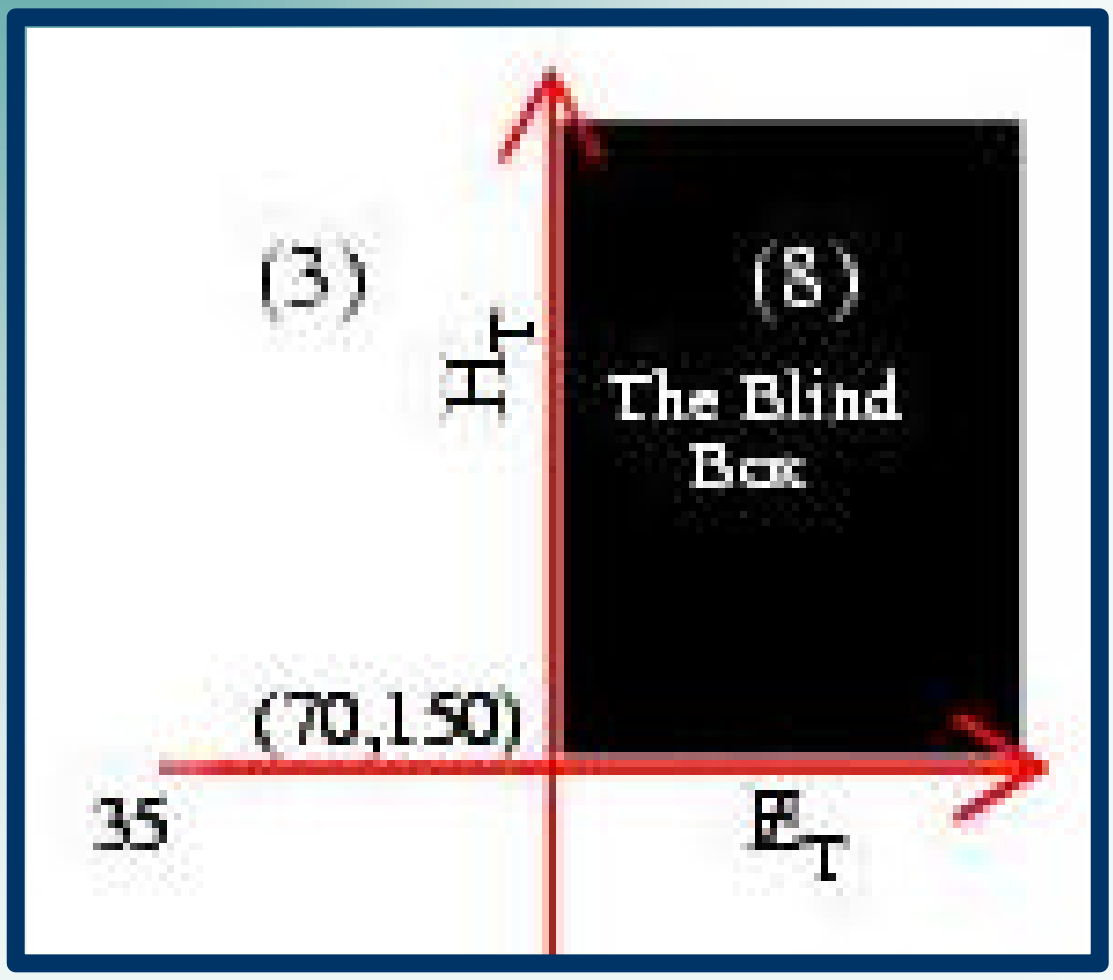


"The BOX"


CDF PRELIMINARY ∫L=84 pb^{-1} √s=1.8 TeV
BOX. SM Prediction=76, Data=74
Events/(5 GeV)
$\not\!\!E_T$ (GeV)
Events/bin
Njet
Events/(8 GeV)
E_T Leading jet (GeV)
Events/(20 GeV)
H_T (GeV)

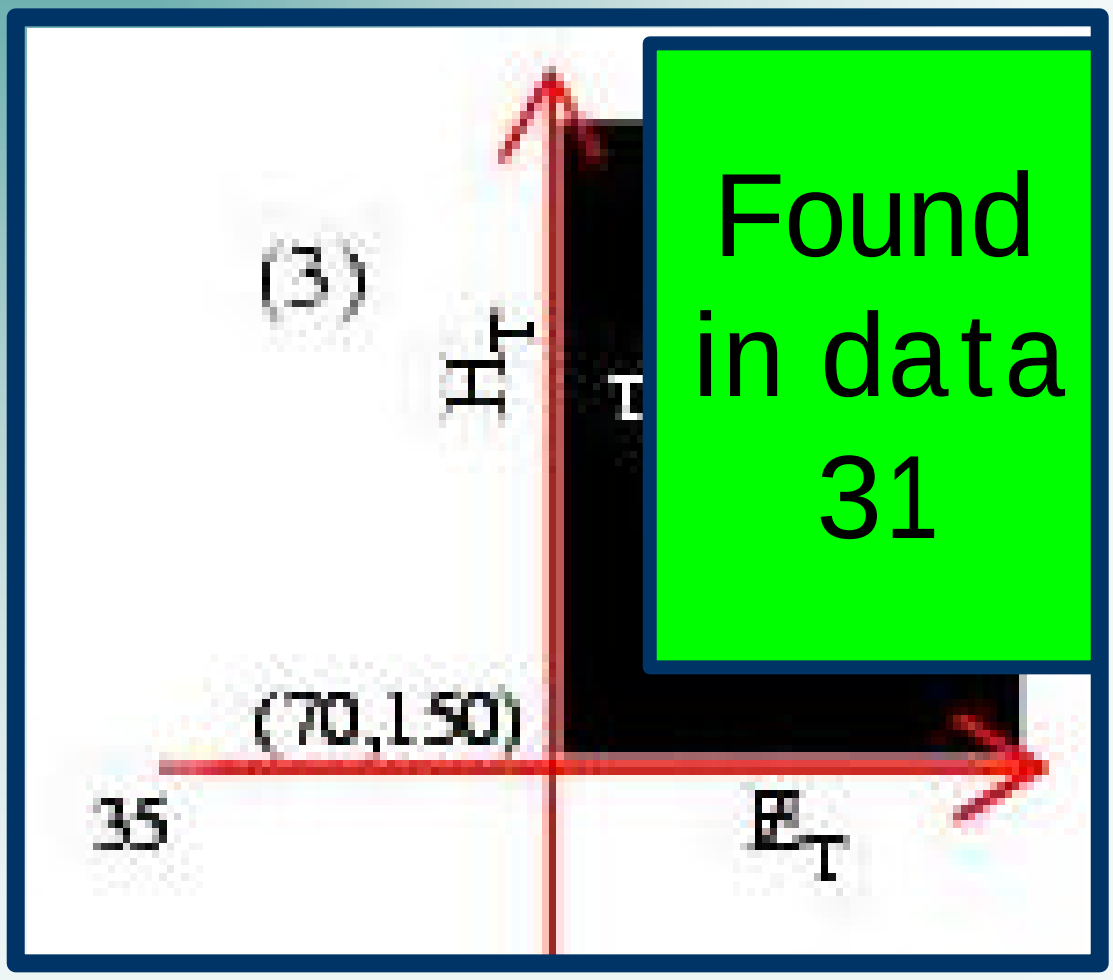
“The other BOXes”

A/D SUSY boxes:
SM Expected 33 7

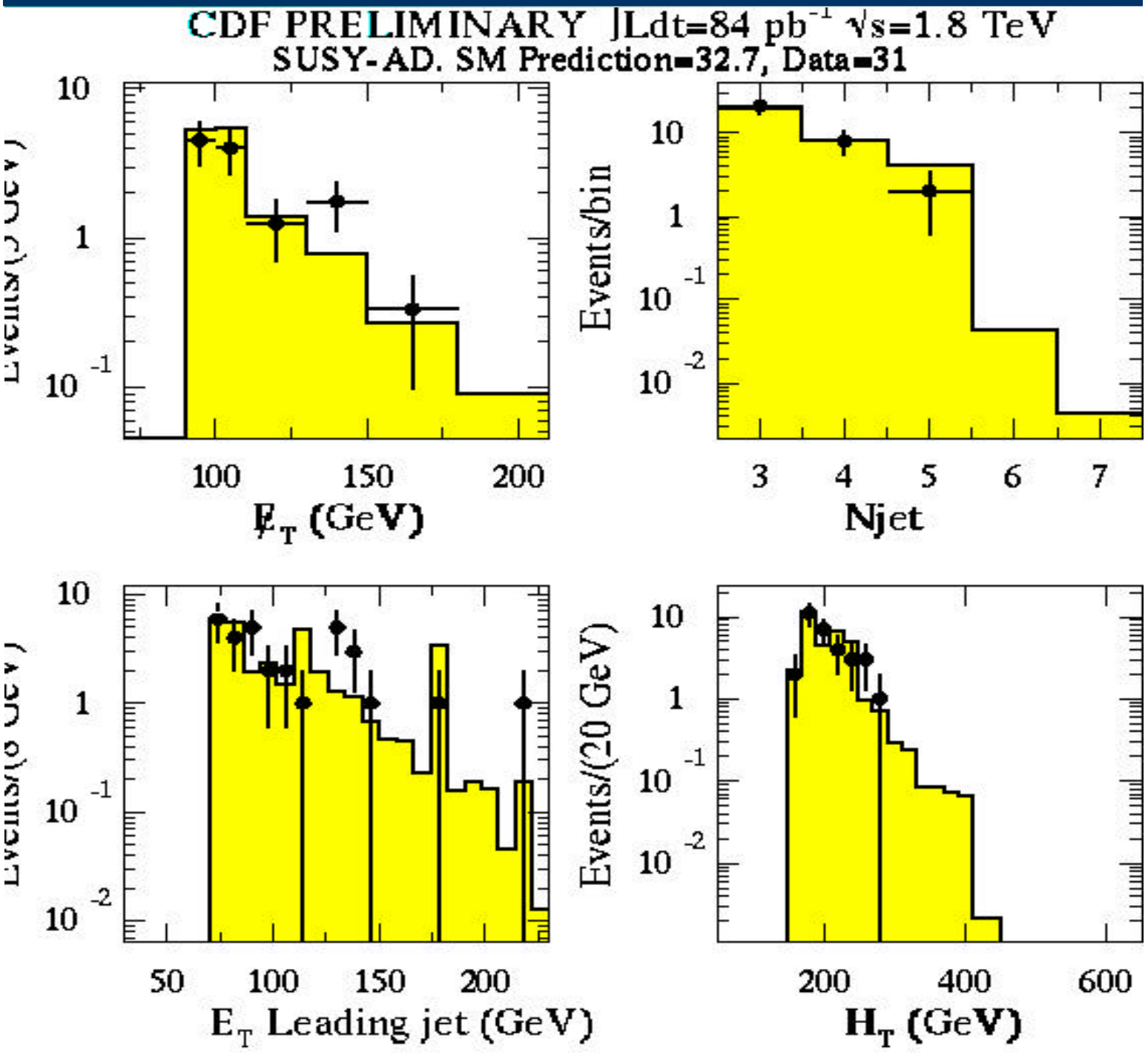


“The other BOXes”

A/D SUSY boxes:
SM Expected 33 7

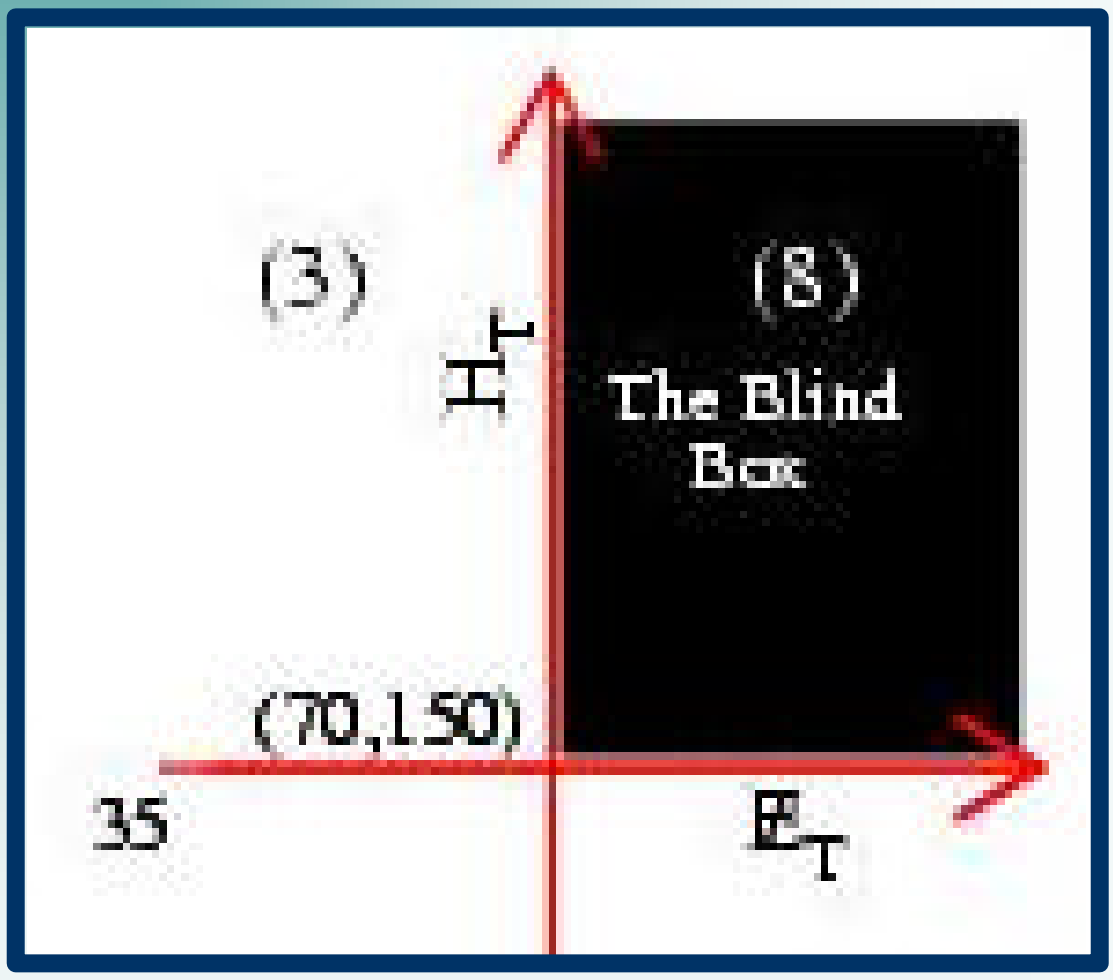


"The other BOXes"



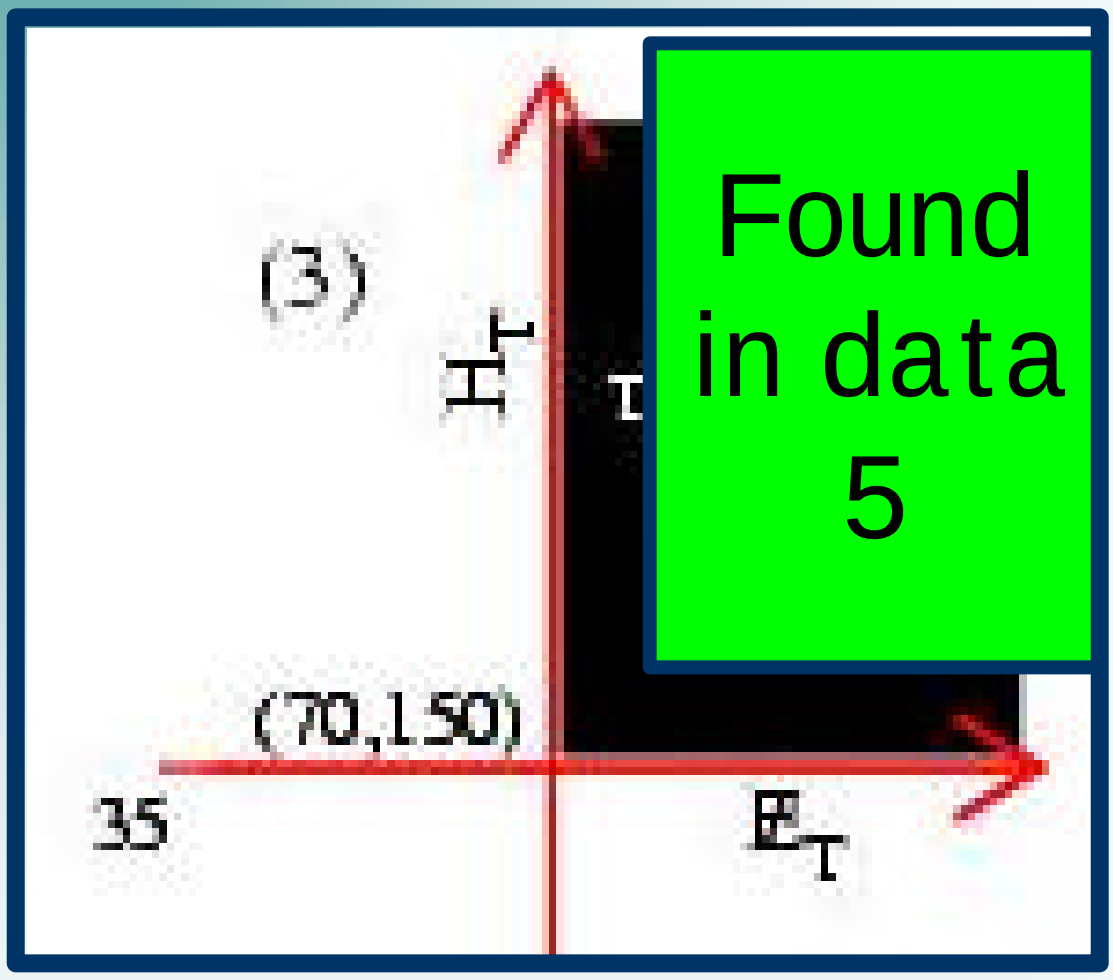
“The other BOXes”

SUSY box B
SM Expected 3.7 0.5

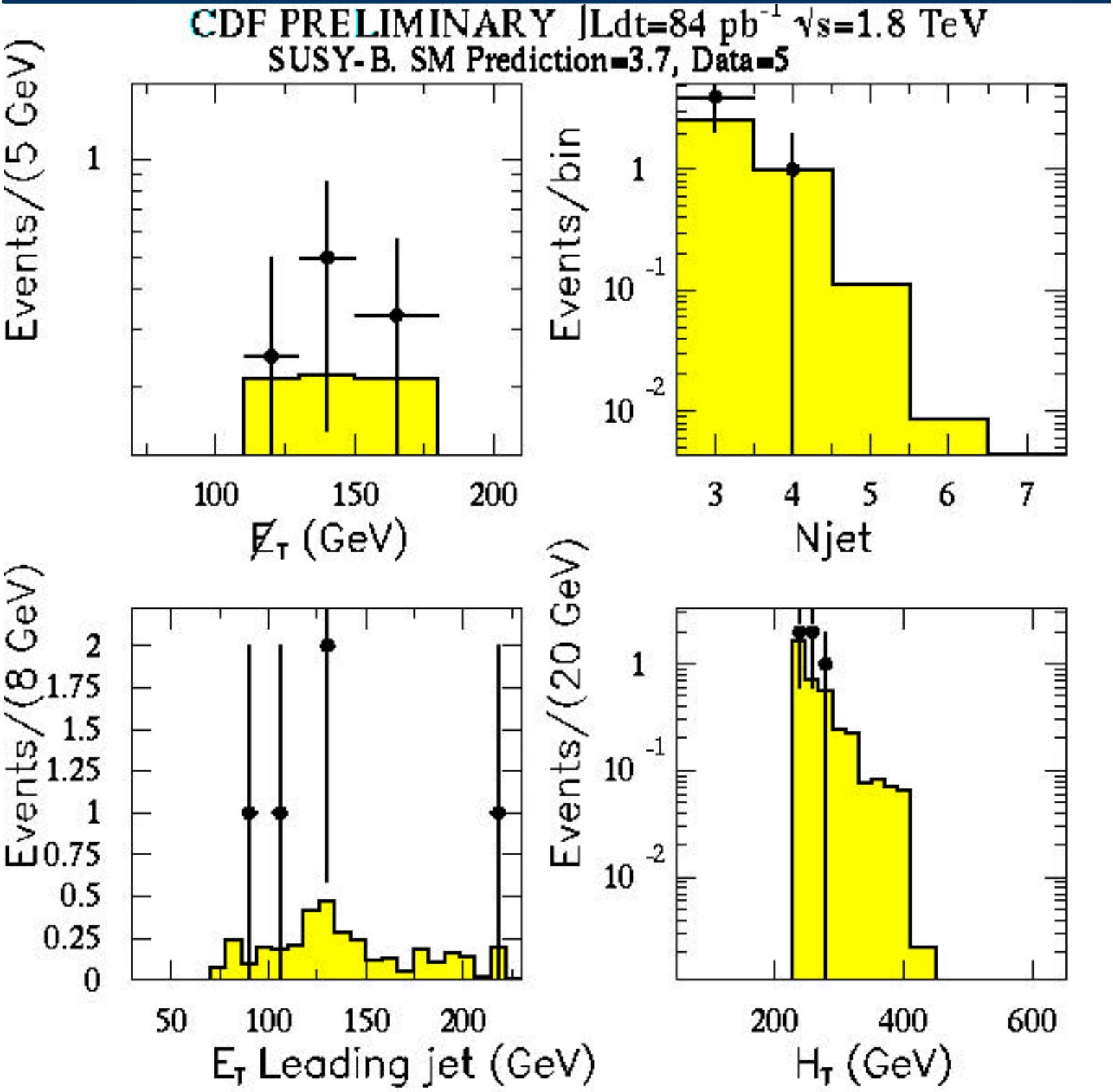


“The other BOXes”

SUSY box B
SM Expected 3.7 0.5

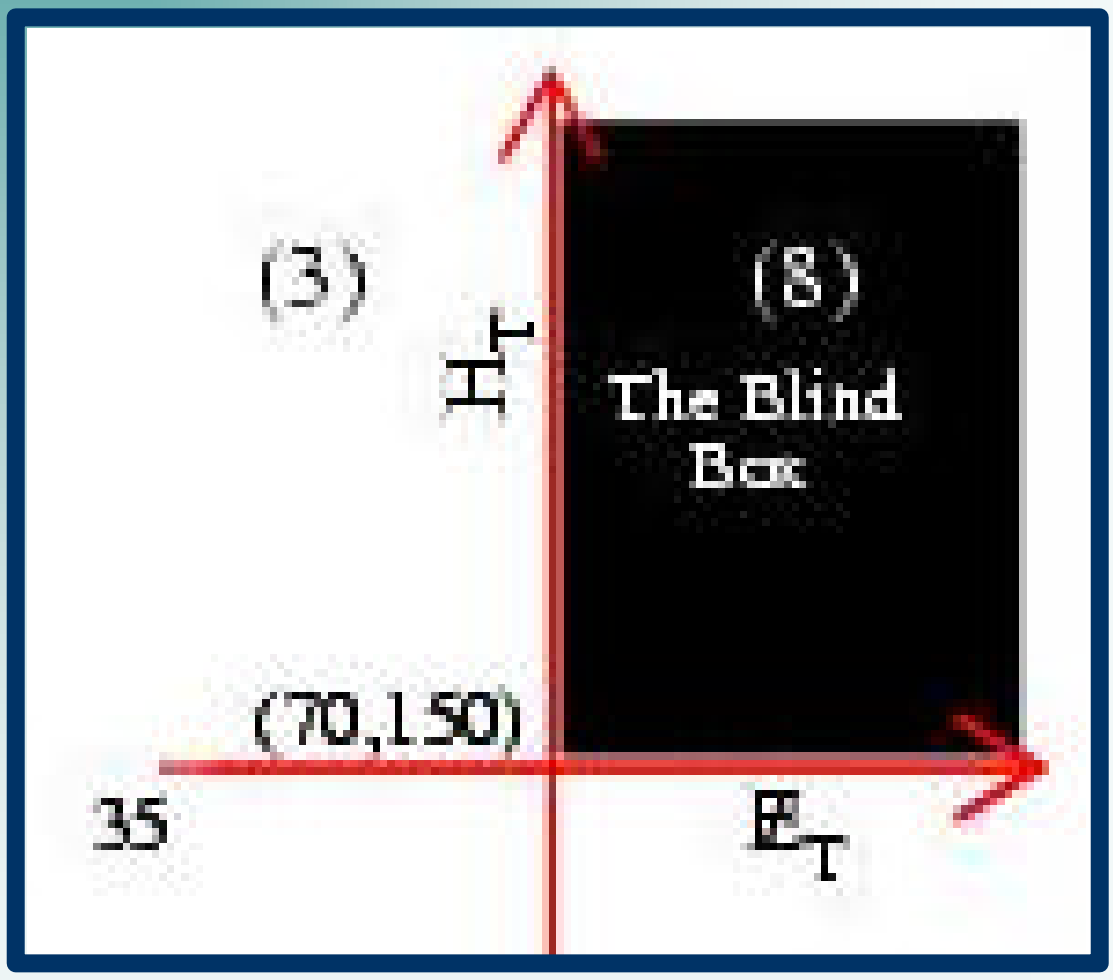


"The other BOXes"



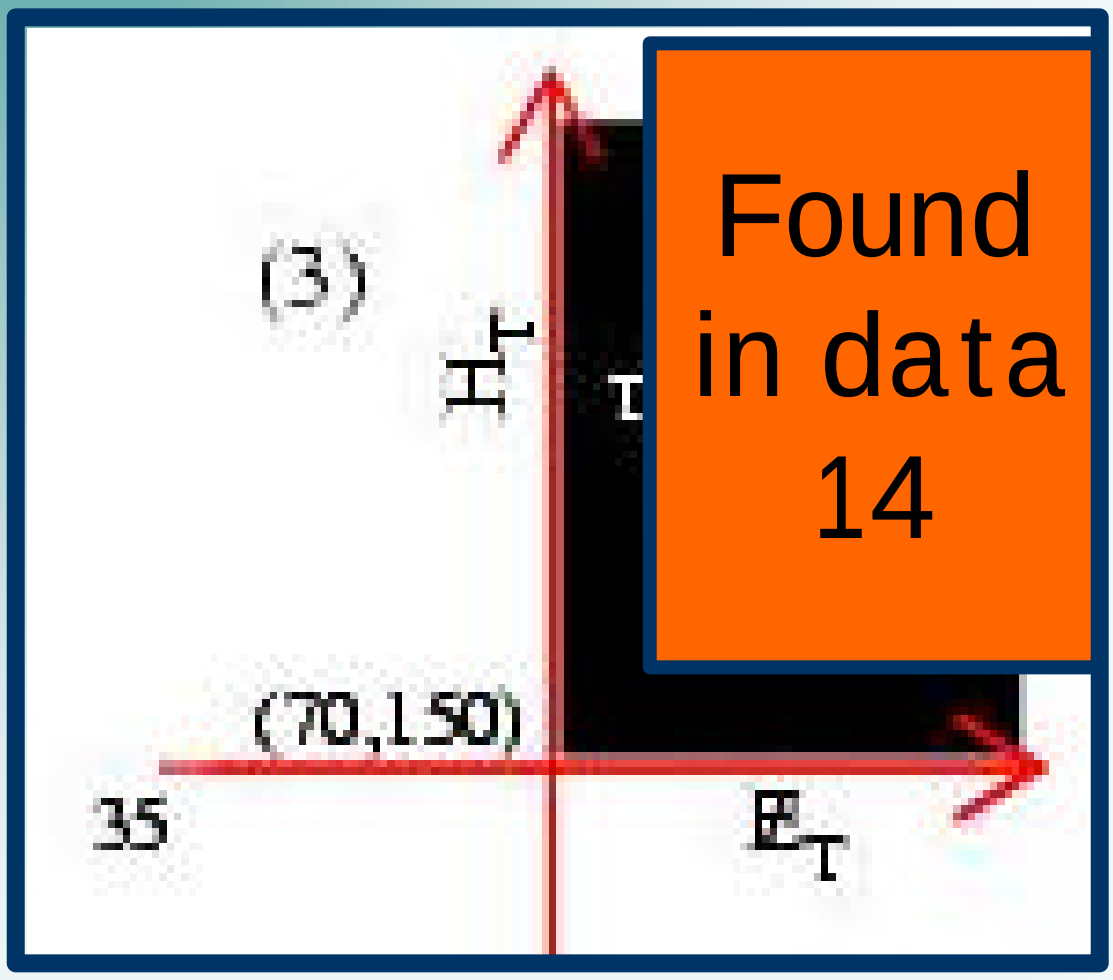
“The other BOXes”

SUSY box C:
SM Expected 10.6✎1

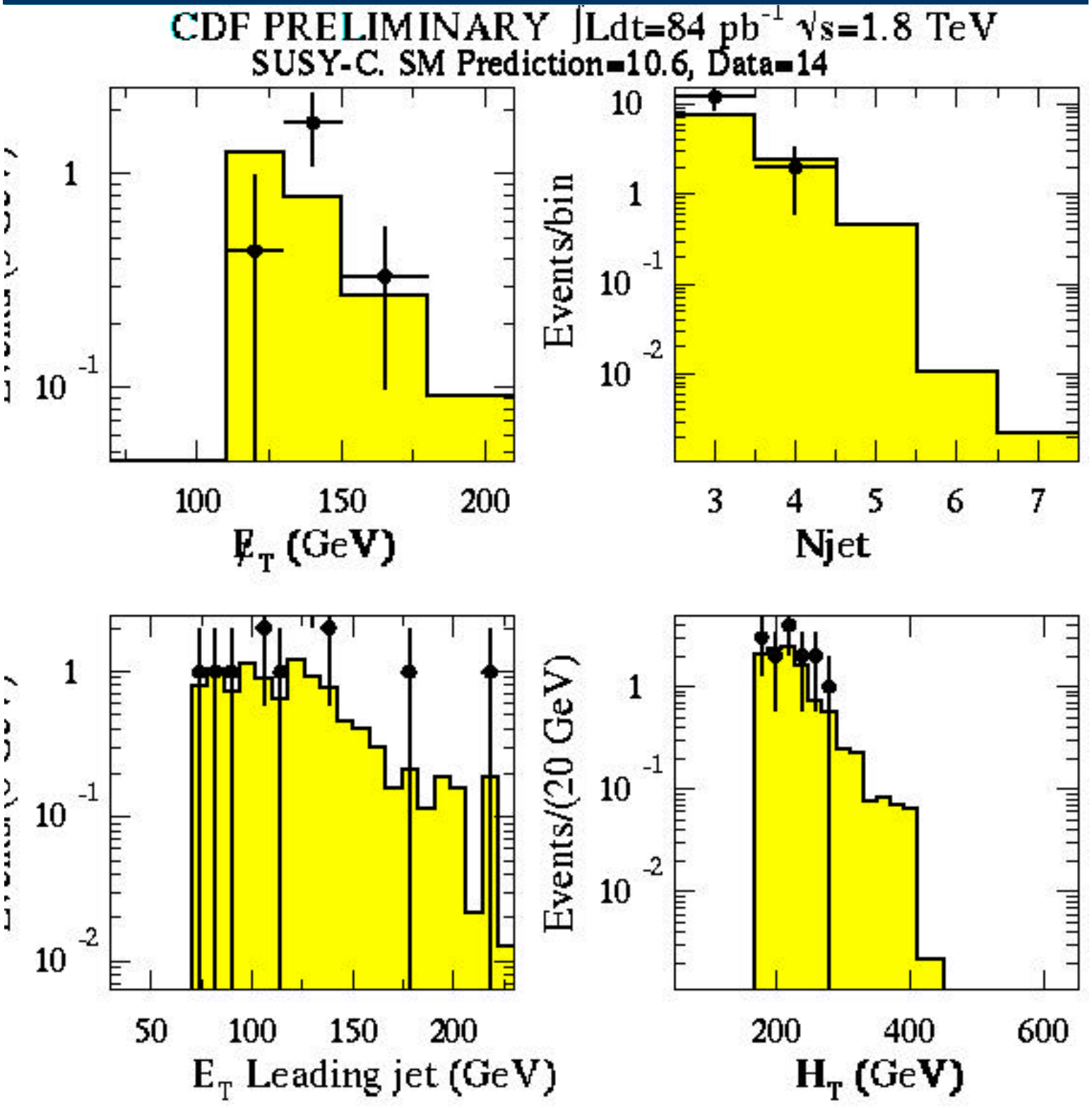


“The other BOXes”

SUSY box C:
SM Expected 10.6✎1



"The other BOXes"

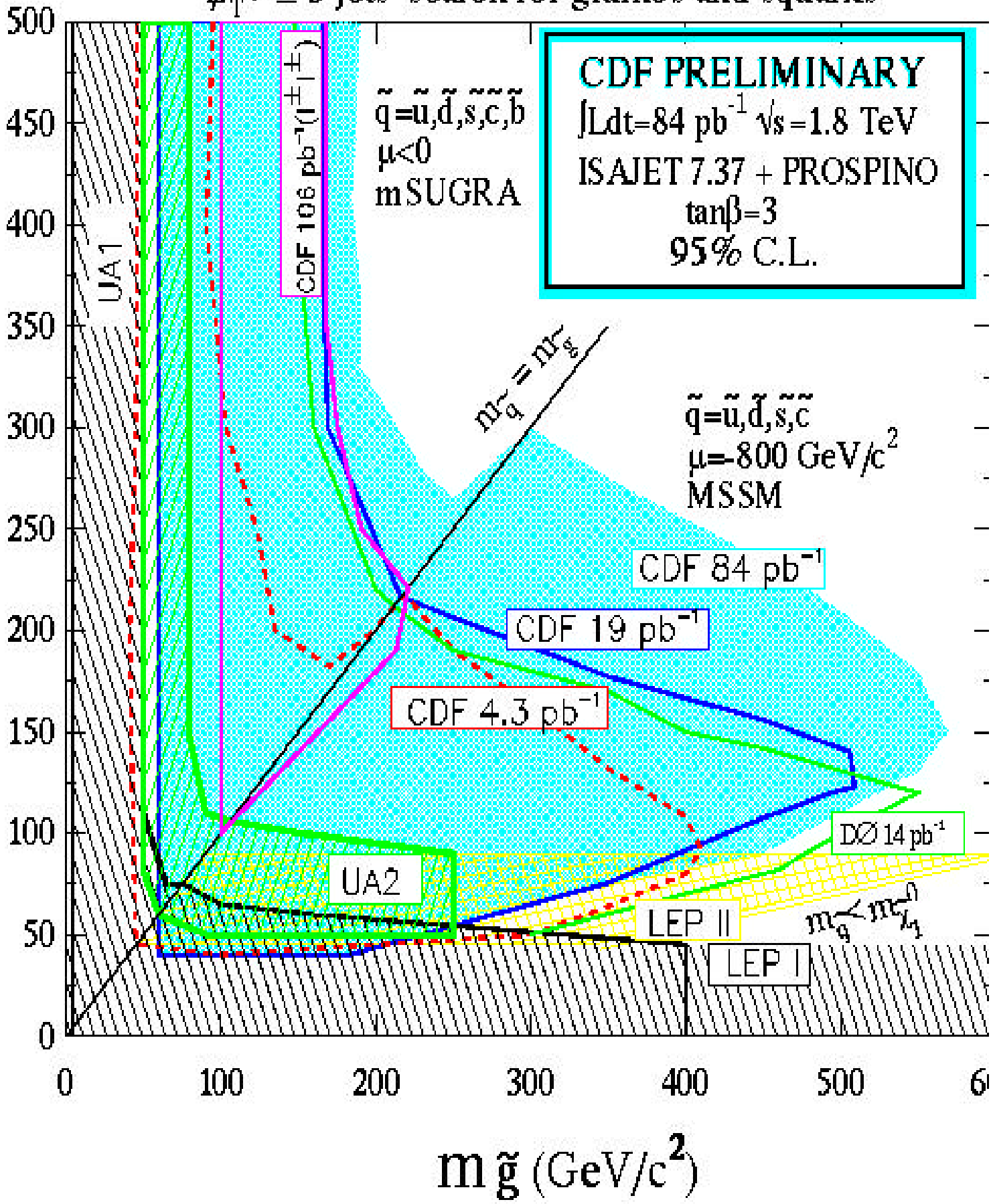


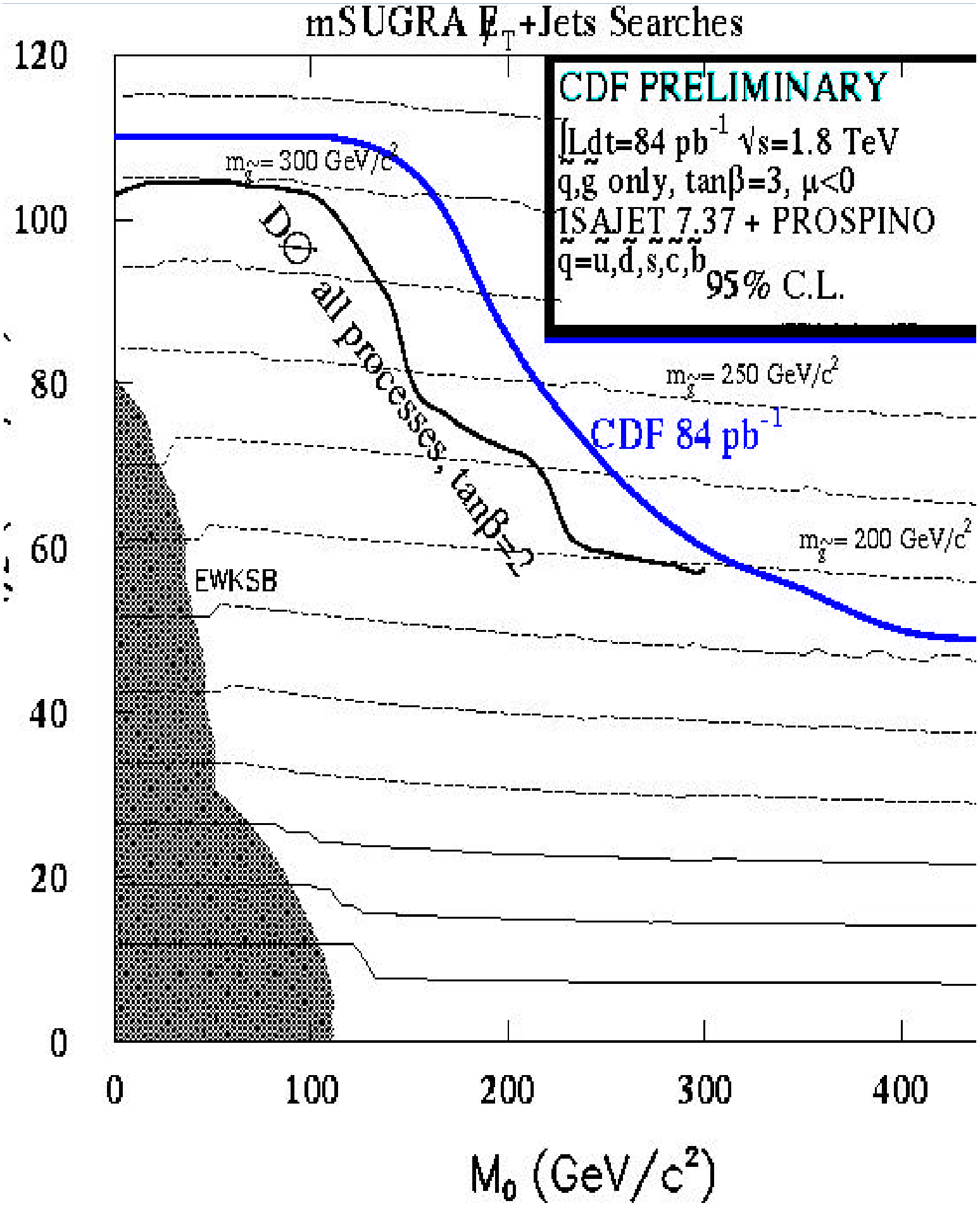
Box	MET,HT	Expected	Observed	$N_{95\% C.L.}$
A	90,160	32.7 ± 6.7	31	17.7
B	110,230	3.7 ± 0.5	5	7.4
C	110,170	10.6 ± 1	14	11.9
D	90,160	32.7 ± 6.7	31	17.3

% Overall Relative Uncertainty on Signal Acceptance

ind	a16	a14	b13	b4	d18	d6
% <PDFs >	6.5	3.5	5.5	4	3	5
% max(Radiation)	12.5	6	3	4	3	3
% $max(Q^2)$	6.5	6.5	5.5	5.5	4	9
% <JET>	4.5	3.5	6	6	3	4
% Trigger	2					
% MC stat.	<0.2					

	A	B	C	D
σ_A%	15	11	11	10


$\not\!\!E_T$ + ≥ 3 jets search for gluinos and squarks
CDF PRELIMINARY
∫Ldt=84 pb^{-1} √s=1.8 TeV
ISAJET 7.37 + PROSPINO
tanβ=3
95% C.L.
$\tilde{q}=\tilde{u},\tilde{d},\tilde{s},\tilde{c},\tilde{b}$
μ<0
mSUGRA
$\tilde{q}=\tilde{u},\tilde{d},\tilde{s},\tilde{c}$
μ=-800 GeV/c^2
MSSM
UA1
CDF 106 pb^{-1} (1 ± 1)
$m_{\tilde{q}} = m_{\tilde{g}}$
CDF 84 pb^{-1}
CDF 19 pb^{-1}
CDF 4.3 pb^{-1}
UA2
DØ 14 pb^{-1}
LEP II
LEP I
$m_{\tilde{q}} < m_{\tilde{\chi}_1^0}$
500
450
400
350
300
250
200
150
100
50
0
0
100
200
300
400
500
$m_{\tilde{g}}$ (GeV/c^2)


mSUGRA $\not\!\!E_T$+Jets Searches
CDF PRELIMINARY
$\int L dt$=84 pb^{-1} $\sqrt{s}$=1.8 TeV
$\tilde{q}$,$\tilde{g}$ only, tanβ=3, μ<0
ISAJET 7.37 + PROSPINO
$\tilde{q}$=$\tilde{u}$,$\tilde{d}$,$\tilde{s}$,$\tilde{c}$,$\tilde{b}$
95% C.L.
$m_{\tilde{g}}$= 300 GeV/c^2
$m_{\tilde{g}}$= 250 GeV/c^2
$m_{\tilde{g}}$= 200 GeV/c^2
DØ all processes, tanβ=3
CDF 84 pb^{-1}
EWKSB
$m_{\tilde{q}}$ (GeV/c^2)
M_0 (GeV/c^2)
0
20
40
60
80
100
120
0
100
200
300
400

or $m_{\tilde{q}} \approx m_{\tilde{g}}$ $m < 300$ GeV/c^2

or $m_{\tilde{q}} << m_{\tilde{g}}$ $m_{\tilde{g}} < 570$ GeV/c

or $m_{\tilde{q}} >> m_{\tilde{g}}$ $m_{\tilde{g}} < 195$ GeV/c

henomenological Implications/Discussio

If the sparticles are too heavy then SUSY requires fine tuning and the hierarchy problem reappears. How much fine tuning is tolerable determines how probable low energy supersymmetry is and how soon it will be discovered.

It has been recently pointed out (Bastero-Gil et al./ Dimopoulos et al.) that the electroweak scale looks more natural if M_3 is relatively small.

henomenological Implications/Discussio

$$= -1.7\mu^2 + 7.2M_3^2 - 0.24M_2^2 + 0.014M_1^2 +$$

The required cancellation is easier if the gluino mass is not so big.

$$M_3 \geq 300 \rightarrow \frac{7.2M_3^2}{M_Z^2} \geq 80$$

ith gaugino mass unification

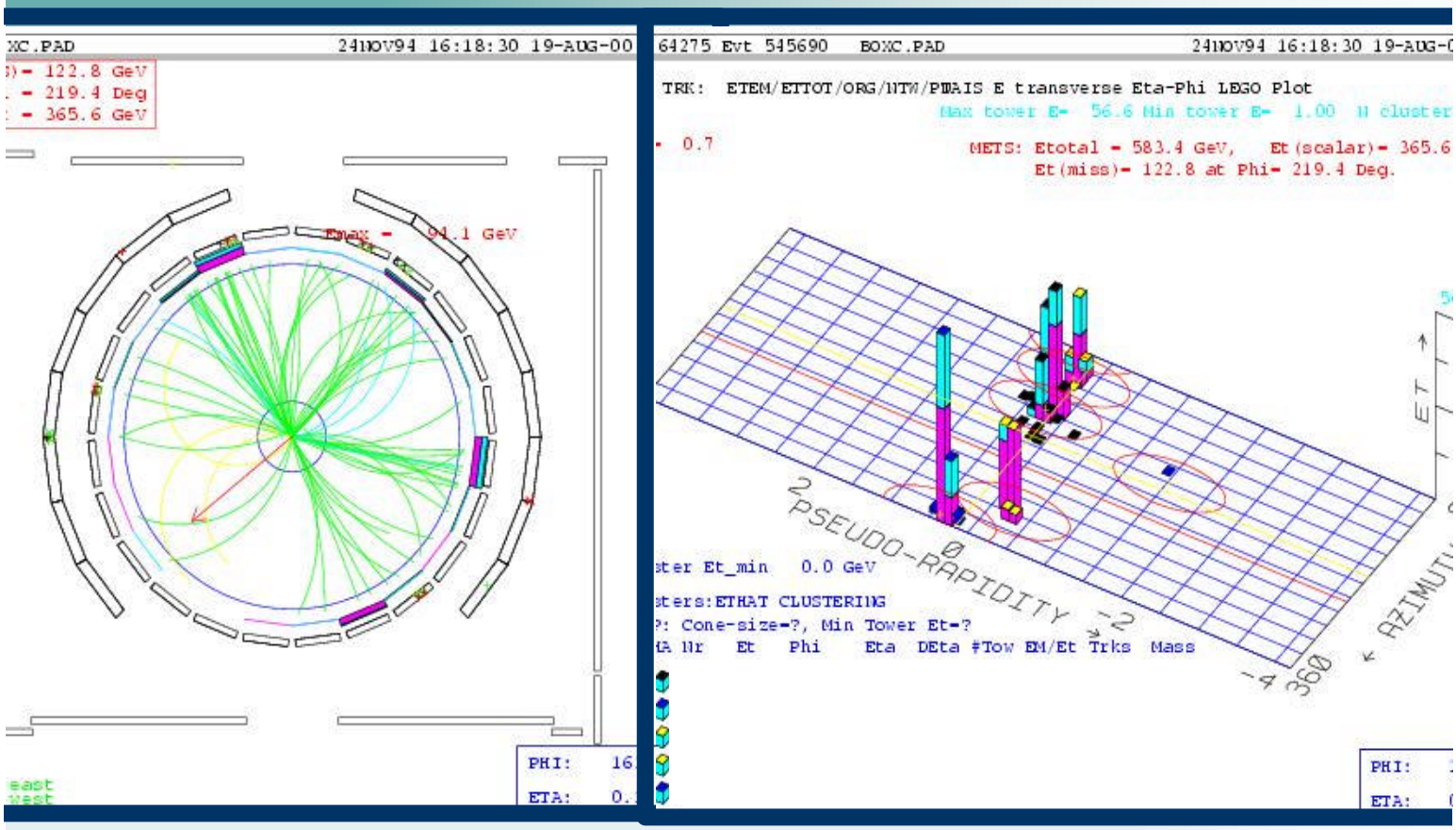
$_1:M_2:M_3::0.5:1:3.3$

ne result of this analysis as well as the EP result on the chargino $M_2<90$ GeV make interesting to drop gaugino unification and low lower gluino mass.

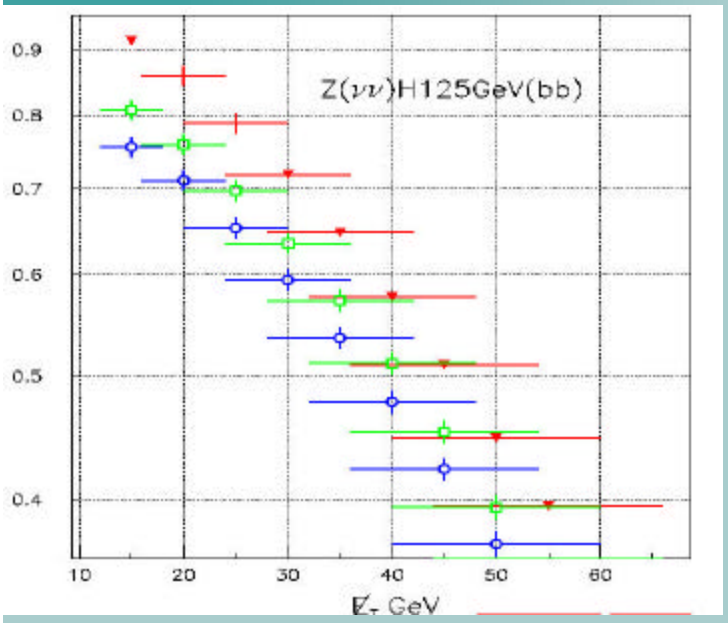
henomenological Implications/Discussio

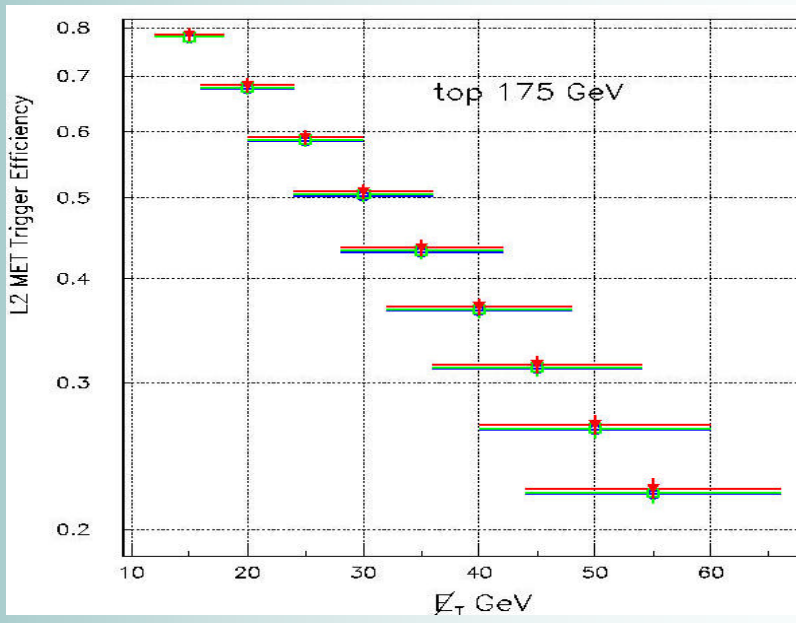
If low energy supersymmetry exists and given that the amount of fine tuning depends critically on the gluino mass, this result indicates that RUNII and the missing energy + jets channel (with lepton veto) constitute a very good probe and have discovery potential.

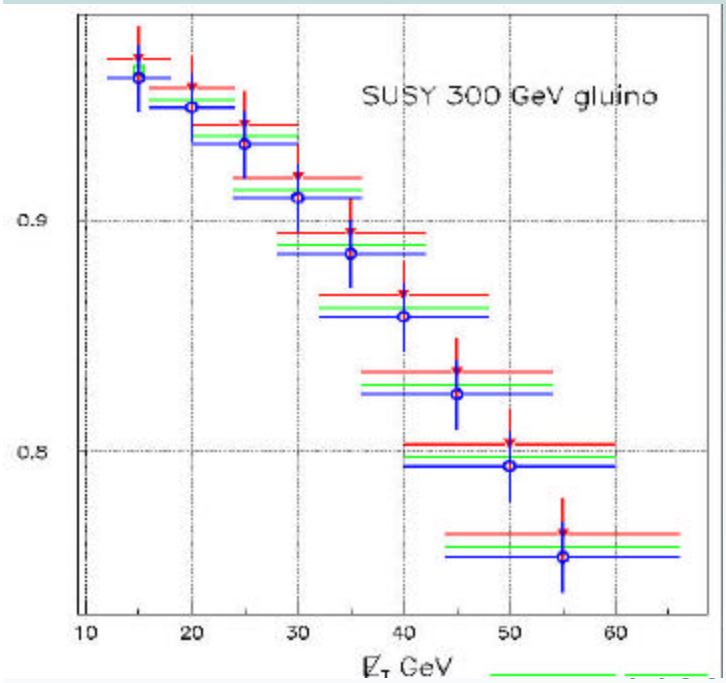
Candidate Event

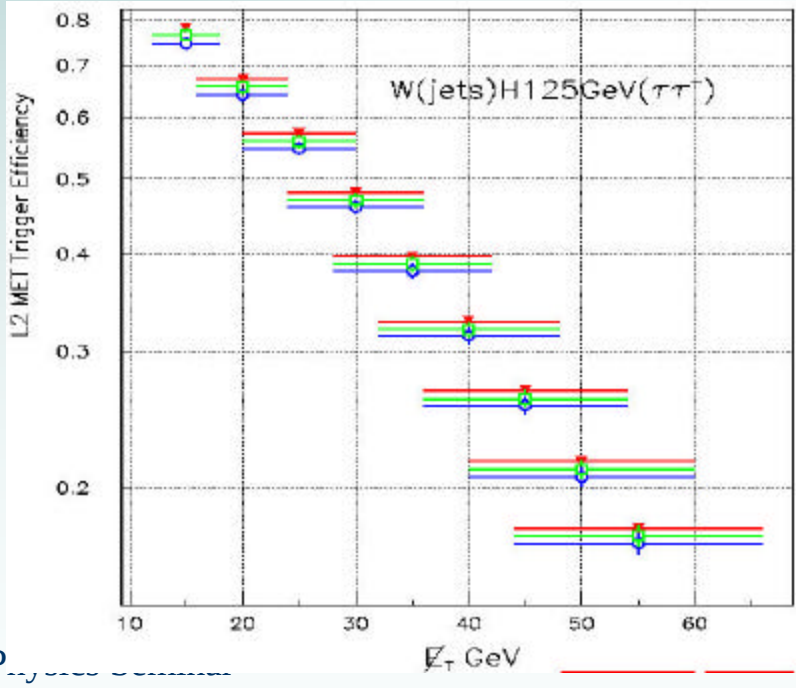


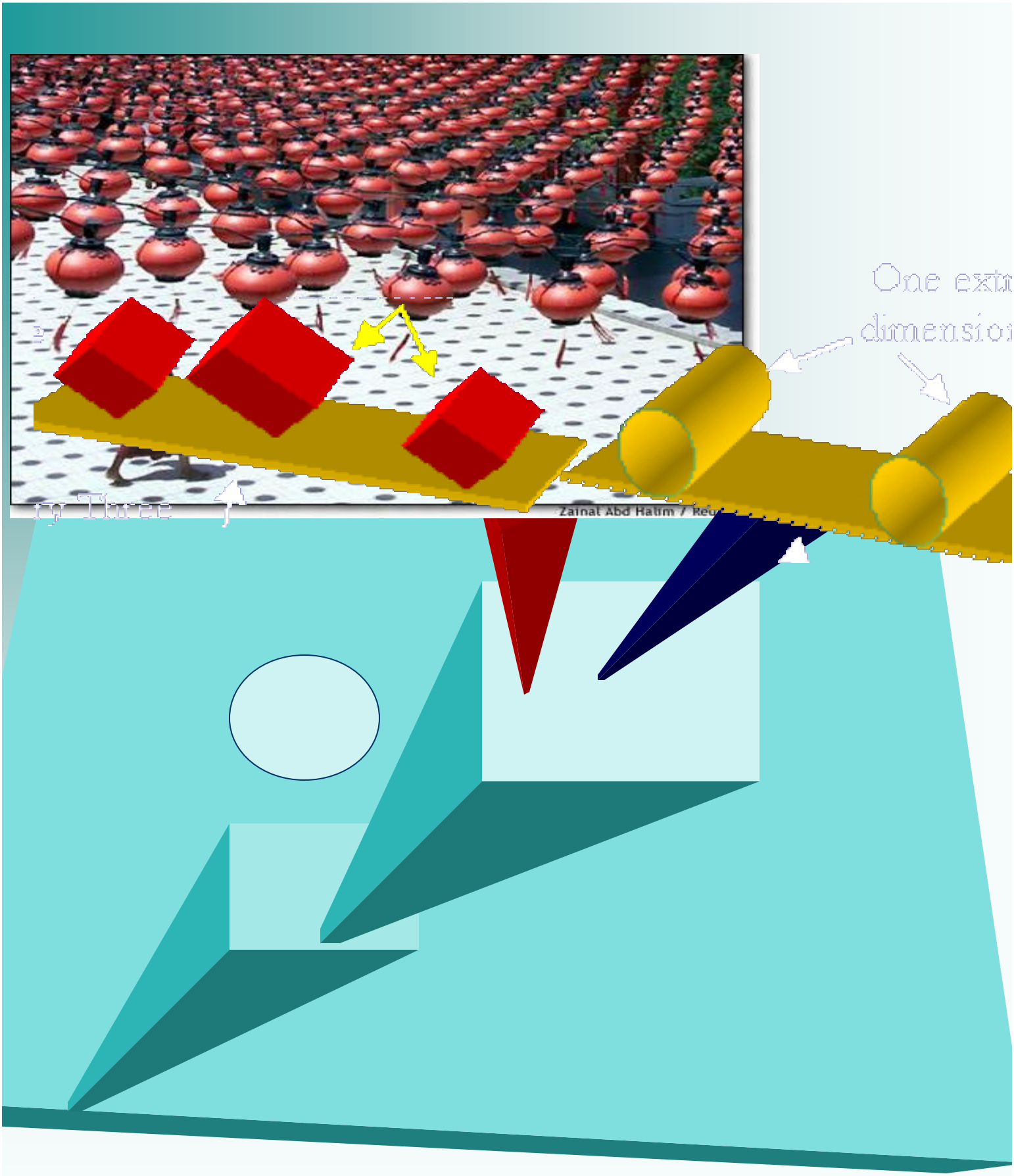
DF L2 MET trigger for RUNII










One exi
dimensio
Zainal Abd Halim / Rev

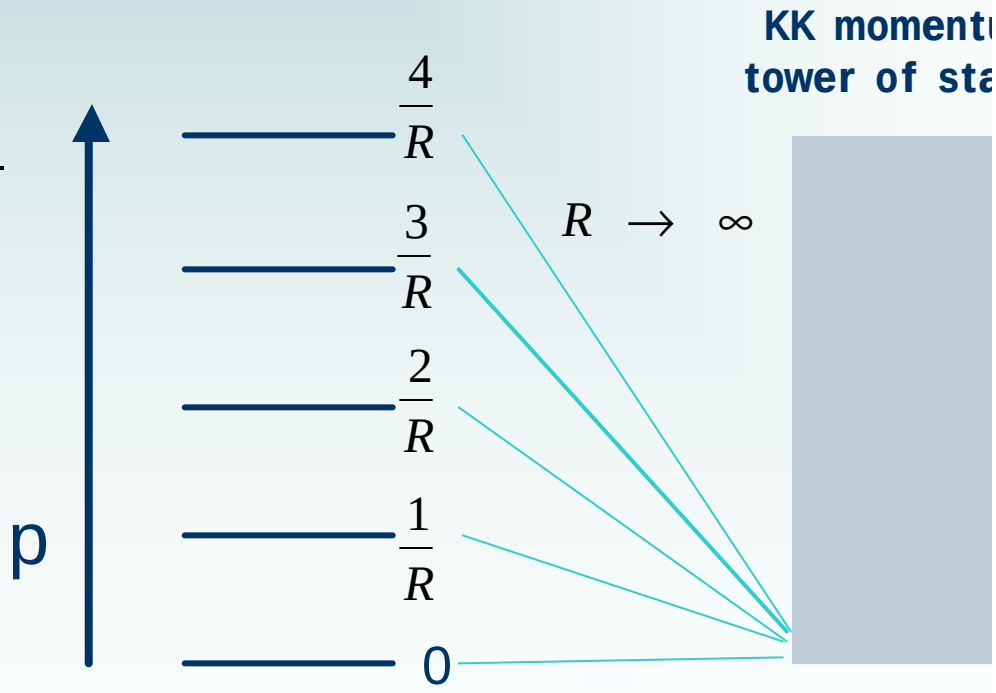
Kaluza-Klein modes

a spatial dimension is periodic then
e momentum in that dimension
quantized:

$$p = \frac{n}{R}$$

From our dimensions of view the KK
modes get mass:

$$^2 = m_0^2 + \frac{n^2}{R^2}$$



Gauss's Law

If the d extra dimensions are compactifid down to si
R, then Gauss's Law

$$V(r) \sim \frac{1}{M_{Pl(4+d)}^{d+2}} \frac{m_1 m_2}{r^{d+1}} \qquad r << R$$

$$V(r) \sim \frac{1}{M_{Pl(4+d)}^{d+2}} \frac{m_1 m_2}{R^{d}} \frac{1}{r} \qquad r >> R$$

$$M_{Planck}^{2} \sim R^{d} M_{Pl(4+d)}^{2+d}$$

The Planck Scale from our dimension of view, 10^{19}GeV

$4+\delta$ Planck Scale
M_s
M_D
M_*

any scale that in the higher dimensional theor is taken O(TeV)

The size of the extra dimension

et the higher dimesional Planck scale to m_{EWK}

e Planck scale to 10^{19}GeV

en

$$R \sim 2 \cdot 10^{\frac{31}{d} - 17} \text{ cm}$$

$= 1 \quad \Rightarrow \quad R \sim 10^{9} \text{ Km}$ **No way**

$= 2 \quad \Rightarrow \quad R \sim 1\text{mm}$

$= 3 \quad \Rightarrow \quad R \sim 1\text{nm}$

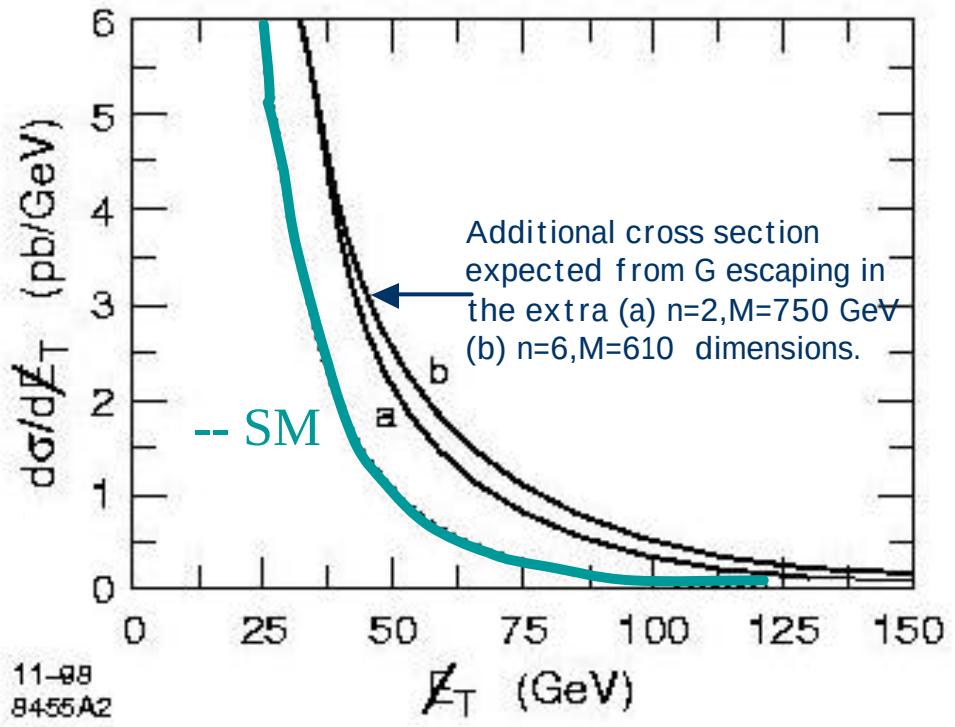
Explore in sub-mm gravitational experiments/collider...

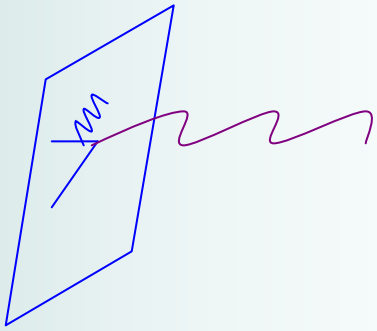
$= 6,7 \quad \Rightarrow \quad R \sim 10 \text{ fm}$

M-theory limits

hep-ph/9811337/ Mirabelli,Perelstein,Pesk

Monojets+Missing Energy





The monojet+Missing Energy result from CDF 88-89 can put the following constrains :

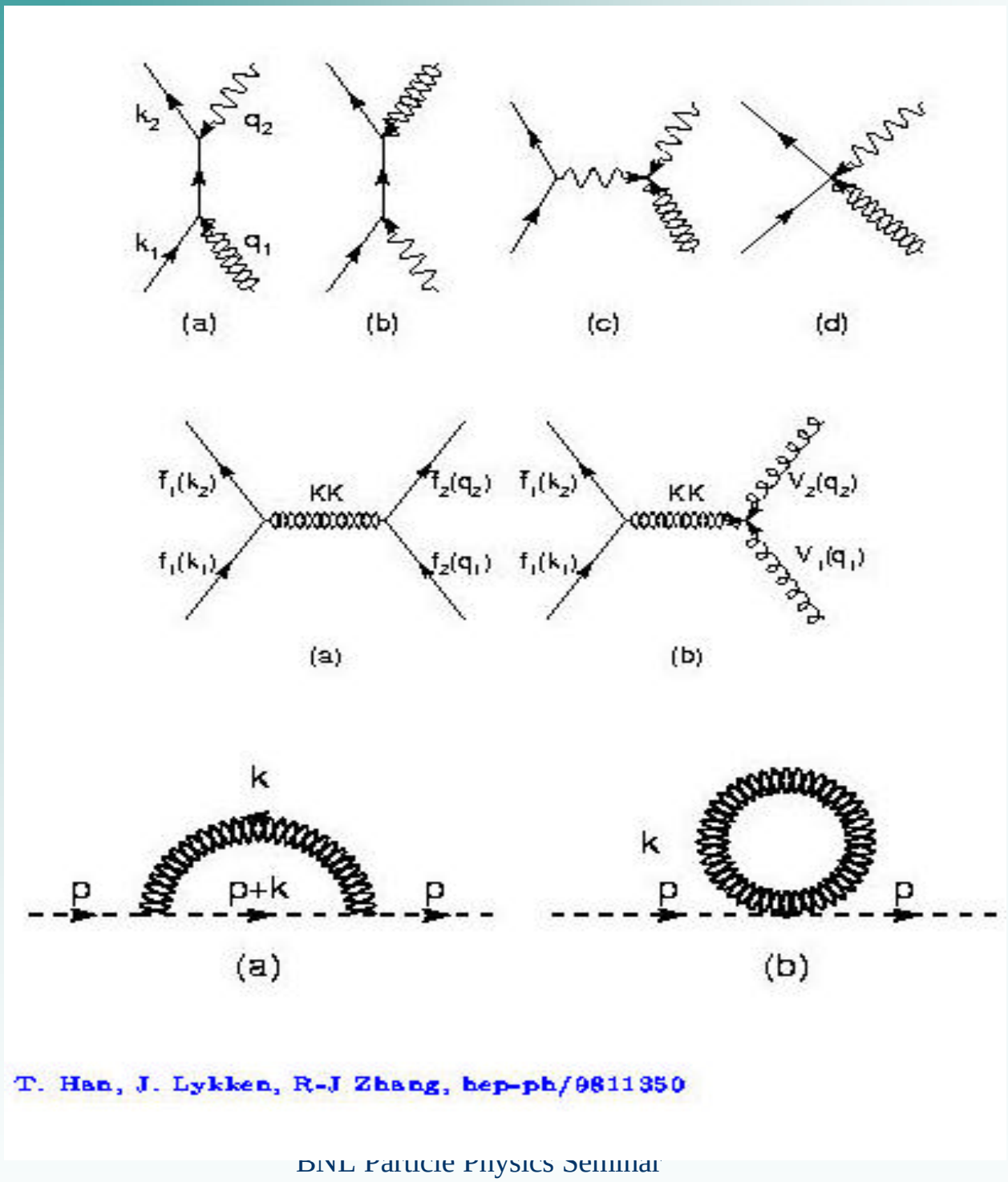
a. n=2, M=750 GeV	**R<0.11 cm**	**M>750GeV**
b. n=6, M=610 GeV	**R<5.8×10^{-12}**	**M>610GeV**

An observation of an excess of Missing Energy events above the SM expectation can provide a direct evidence for this class of models.

The extra world picture

- The SM is confined on a 4d wall
- Gravity exists in a 4+d “bulk”
- Gravity feels week on the wall because of the enormity of the bulk volume
- Each KK-graviton state couples to the wall with Planck suppressed strength
- The number of KK-states ~$(ER)^{\delta}$
- The sum over all KK-states is not M_{Pl} suppressed but $M_{Pl(4+\delta)}$ suppressed i.e. M_{EWK} suppressed so we have sizable cross sections

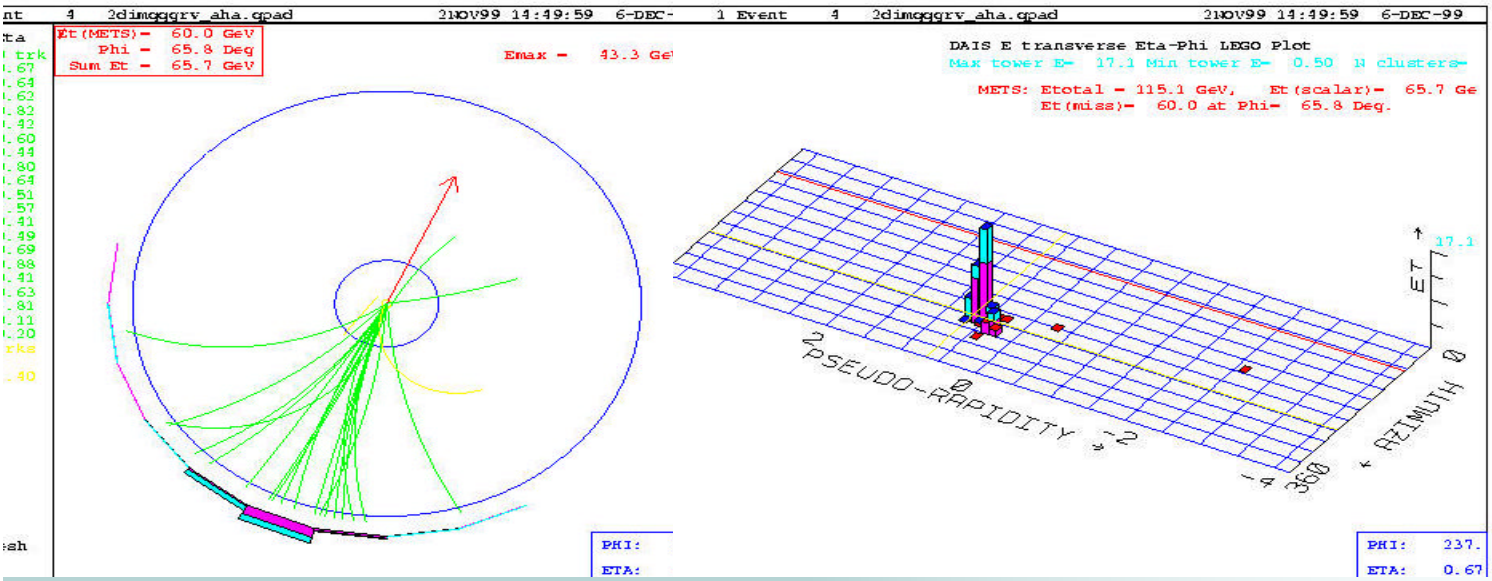
Graviton emission,exchange

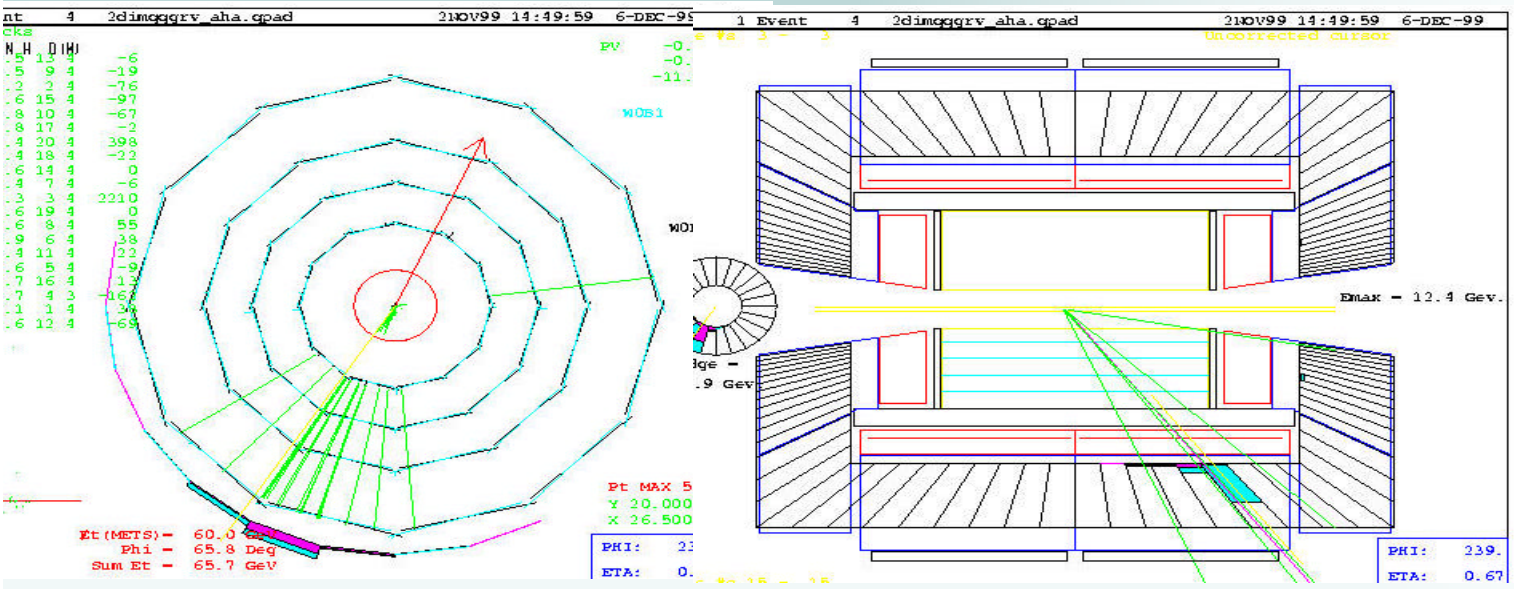


T. Han, J. Lykken, R-J Zhang, hep-ph/9811350

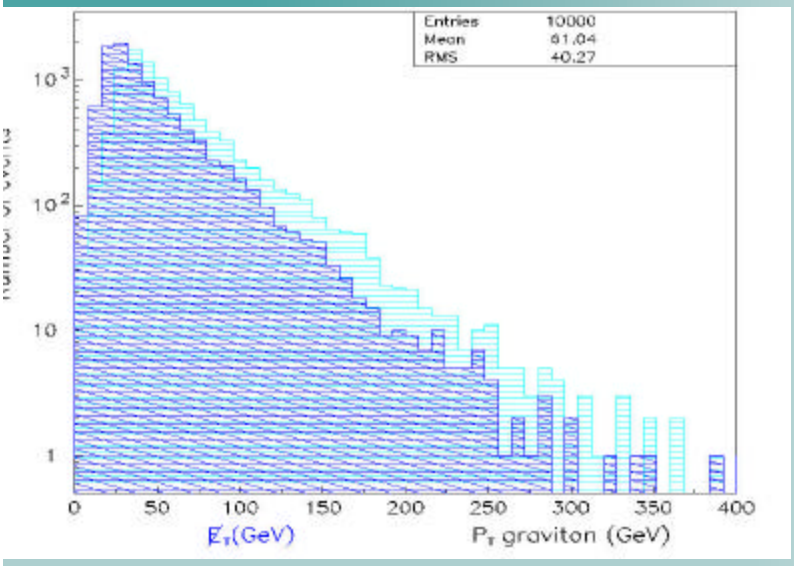
Graviton @CDF

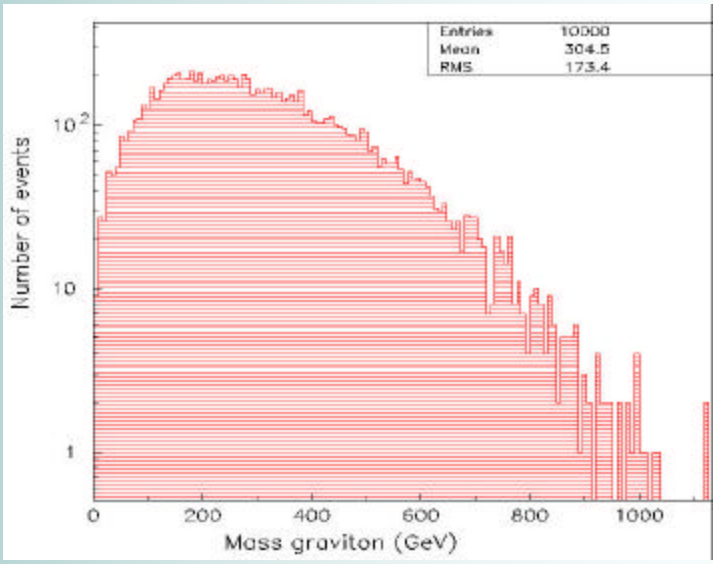
N=2 M=1TeV

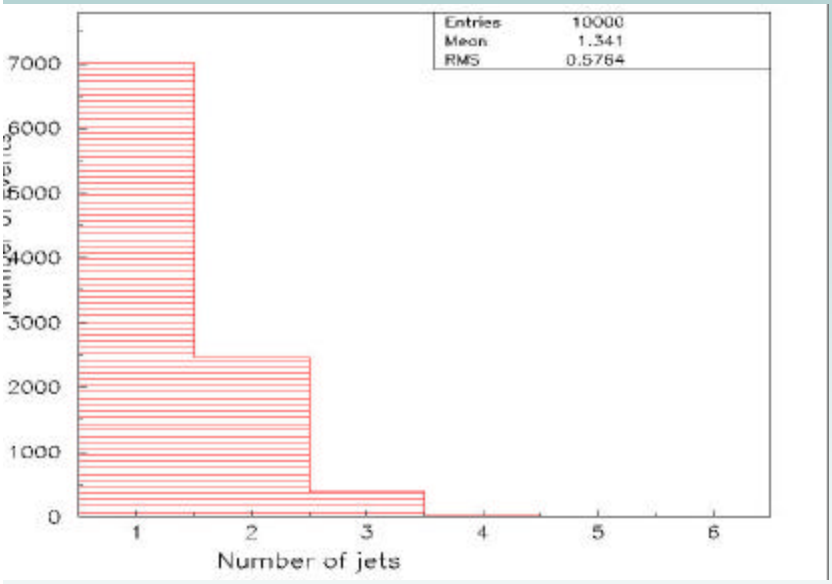




N=2, M=1TeV

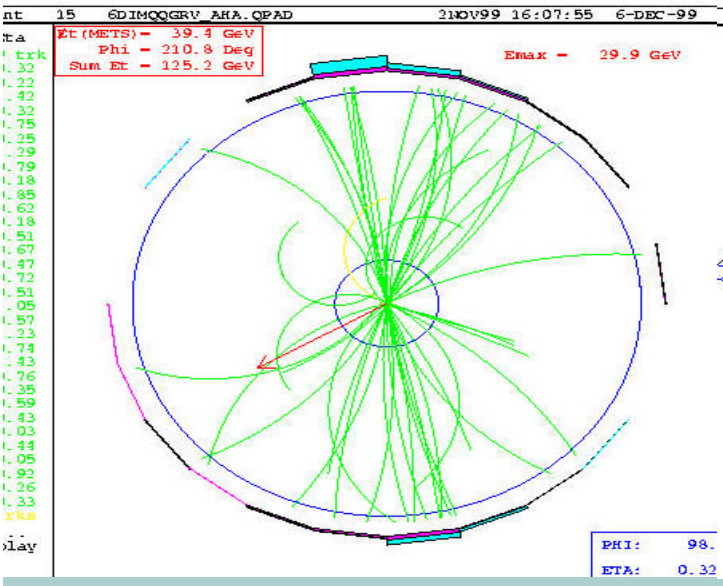


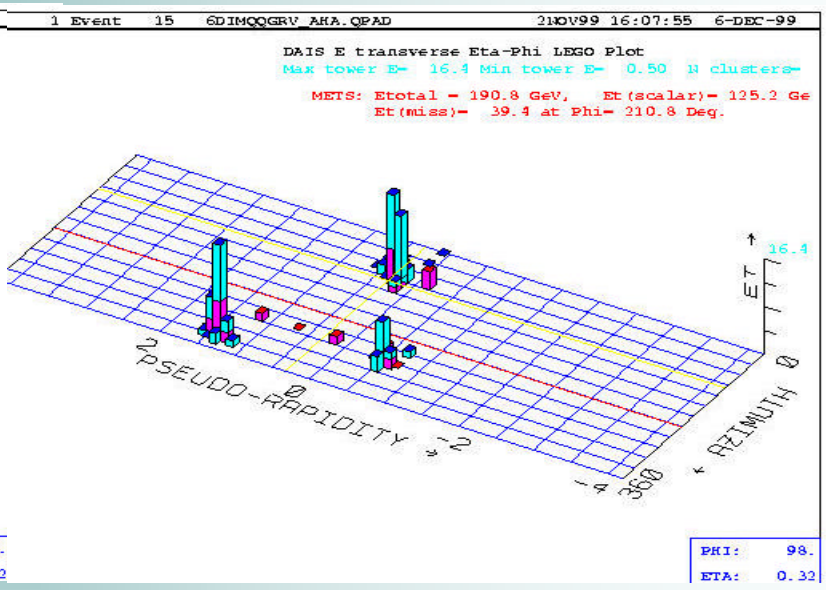


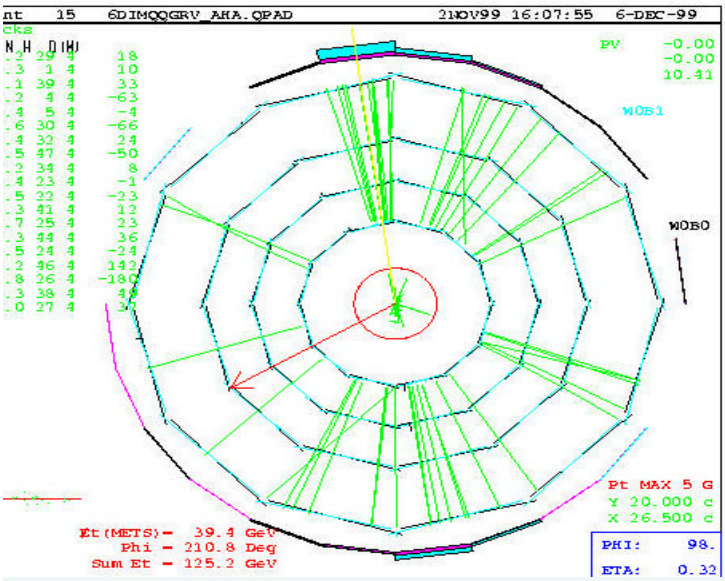


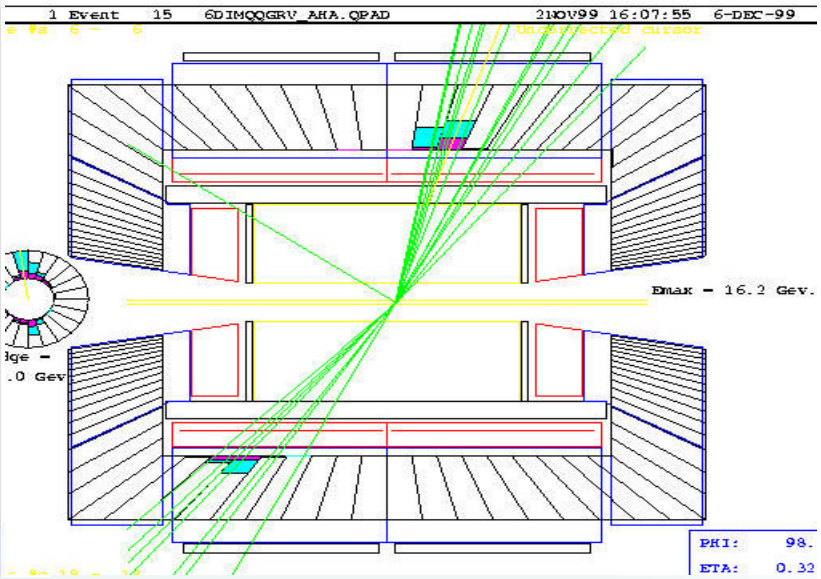
Only qqbar->g G (PYTHIA 6.115 + graviton process)

GRAVITON @CDF



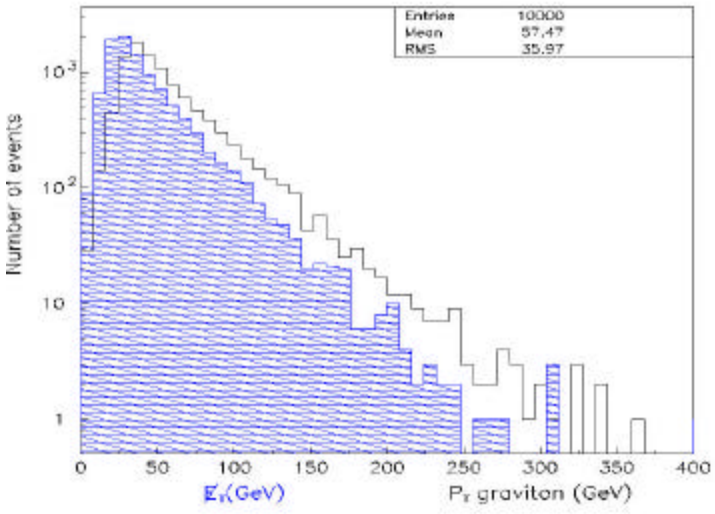


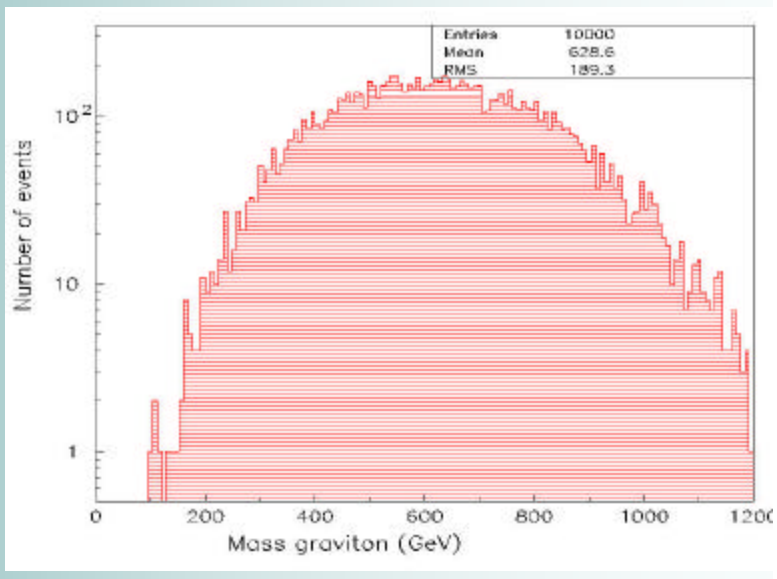


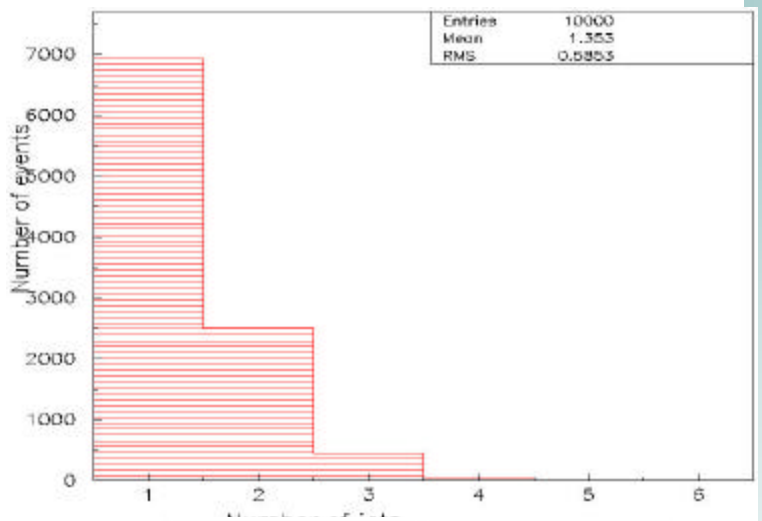


N=6 M=1TeV

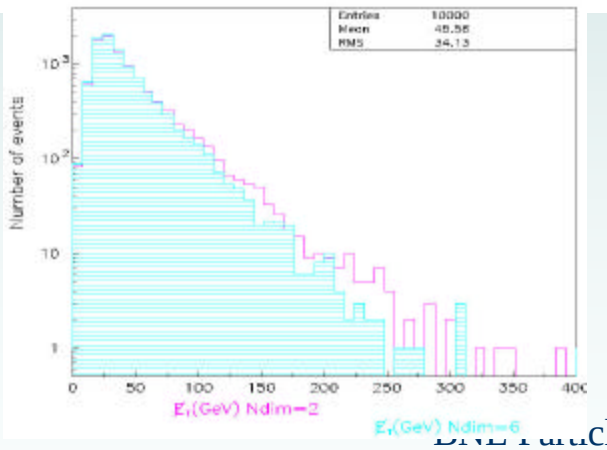
N=6 , M=1TeV

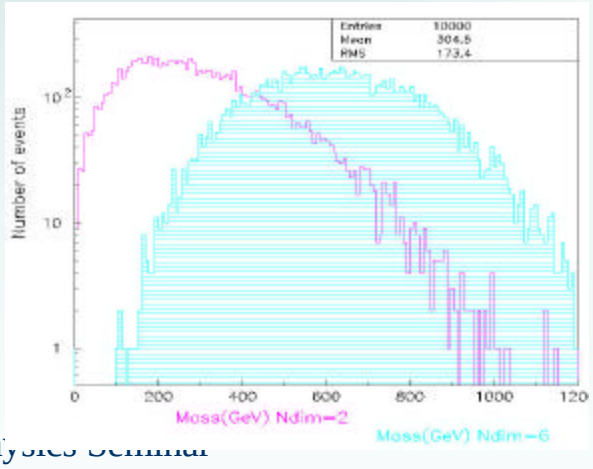




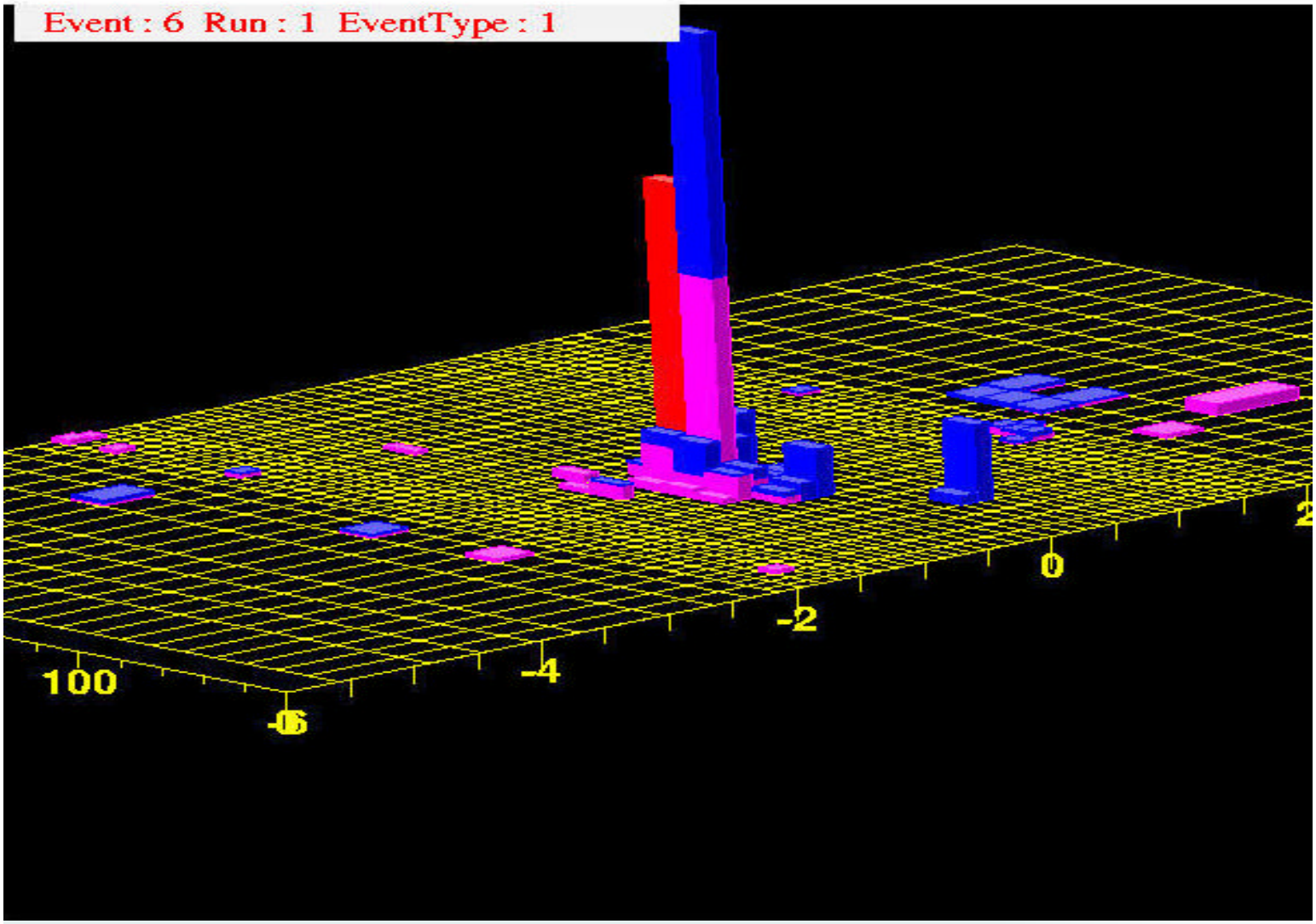


Only qqbar->g G (PYTHIA 6.115 + gravion process)



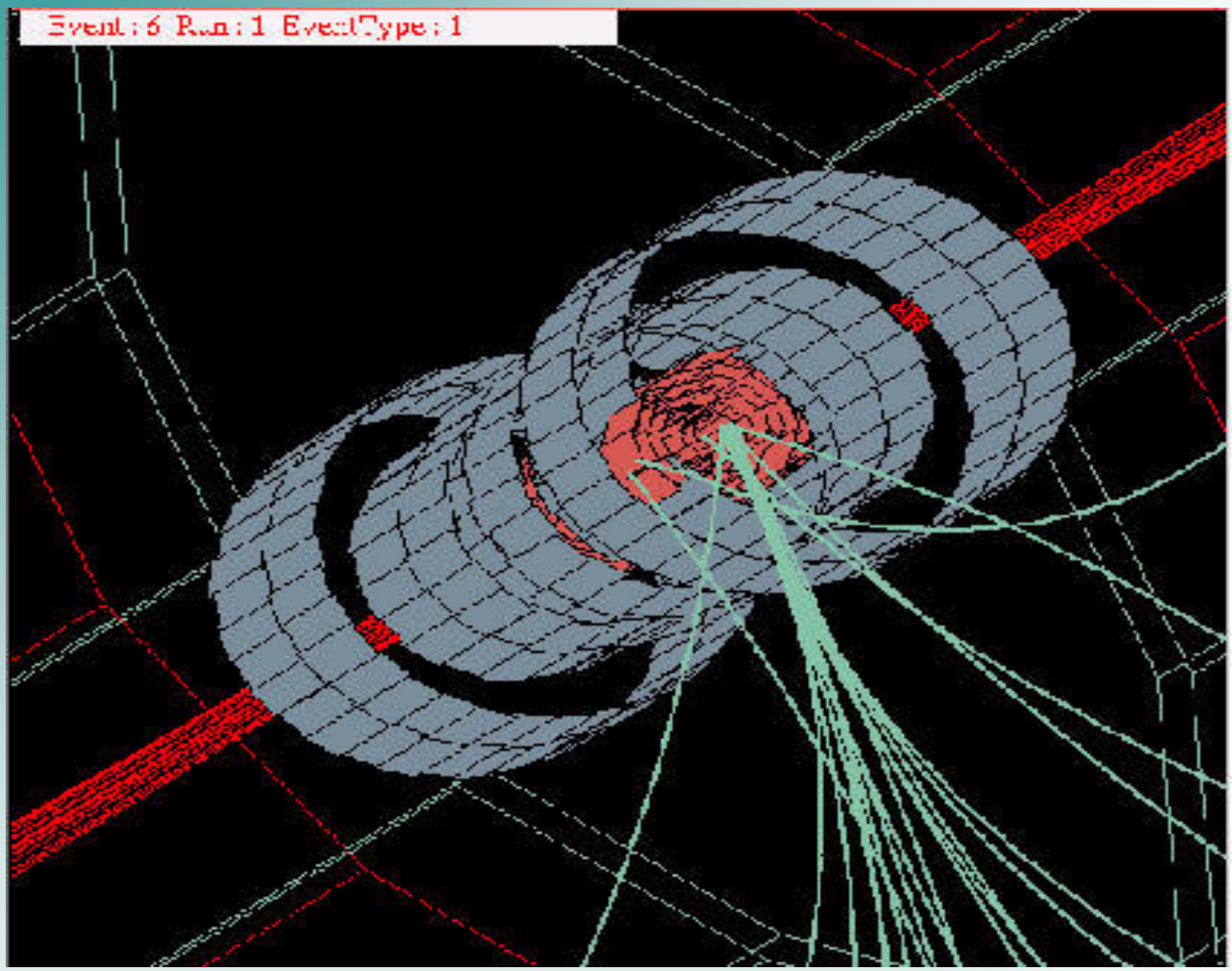


RUNII Display



Only qqbar->g G (PYTHIA 6.115 + graviton process), δ=6, M=1TeV, √s=2TeV, GEANT CDF preliminary
RUNII simulation and display

RUN II Display



Only qqbar->g G (PYTHIA 6.115 + graviton process), δ=6, M=1TeV, √s=2TeV, GEANT CDF preliminary

RUN II simulation and display