Global Search for High-Pt Physics at CDF

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Why a Generic Search?

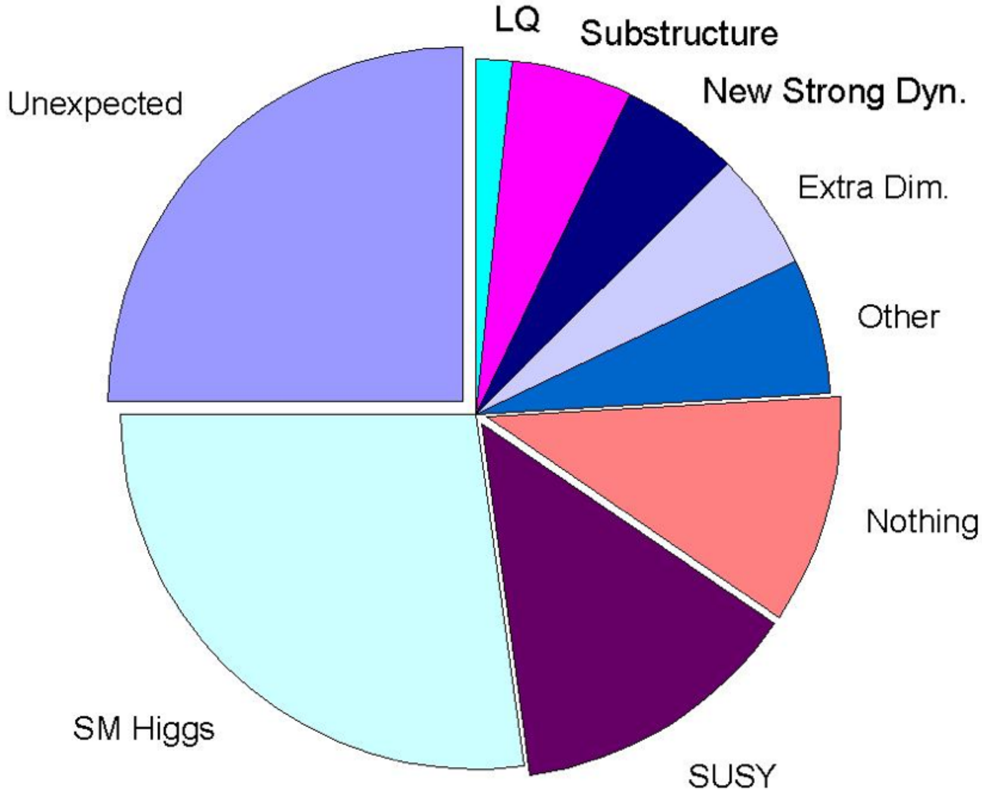
Point 1: The list of potential models is endless…
and each has many variations, parameters..
and several could be occurring simultaneously…

Illustration by Hitoshi Murayama

Why a Generic Search?

Point 2: no significant data hints
and no agreement on the most compelling guess..

survey of FNAL grad students:
what do you expect next?



Why a Generic Search?

Point 3: tying searches to theory has unintended consequences

- highly specific searches
- narrow results
  - reporting only a single event count, one limit plot
- discrepancies not fitting the model tend to be avoided instead of investigated
- not all signatures are covered, some are over covered
- results become obsolete if theory becomes obsolete
- if no big limit space, the work is still valuable, but ignored
- model takes time away from experimental techniques

We are experimentalists, and should be doing experiments

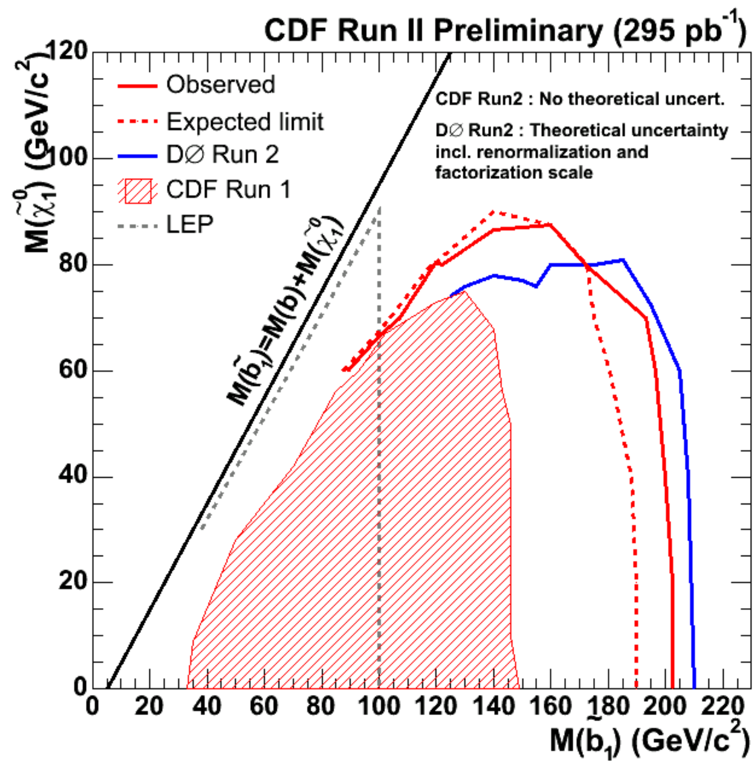
Search for Chargino-Neutralino Production in $p\bar{p}$ Collisions at $\sqrt{s} = 1.96$ TeV

Why a Generic Search?

But, but …

♦ that's the way we have always done it
♦ without a model there is no motivation
♦ model helps tell a story in the paper and presentations
♦ model limits advance the theory knowledge
♦ strictly optimized searches are good training for students
♦ while covering models we can in parasitically cover all signatures

♦ lets us compare with DØ



Themes

Virtually all of the basic techniques
used here are the same as other high-pt searches,
just automated and scaled up

Statistical evaluations are precise
and include trials factors

We are not blind – we constantly look
at all the data and iterate

Vista

A panoramic view of the bulk of all kinematic distributions of all high-Pt data

Sleuth

Examine the tails of the SumPt distributions of all high-Pt final states

Vista

1) select High-Pt objects
2) generate Monte Carlo
for SM backgrounds
2a) fake rate study
3) sort by exclusive
final states
4) fit correction factors
5) compare counts and
kinematic distributions
6) iterate to debug

The Vista Philosophy

All data are treated as both signal and control

one person's control region is other's signal region

...many, many effective control regions!

Goal is to identify a discrepancy on which we can

base a new physics claim

NOT obtain a perfect description of data

Nothing gets cut away

Keep model simple

Focus on discrepancies,

ask: is there a mundane explanation?

Require any change is physically motivated and

improves overall agreement

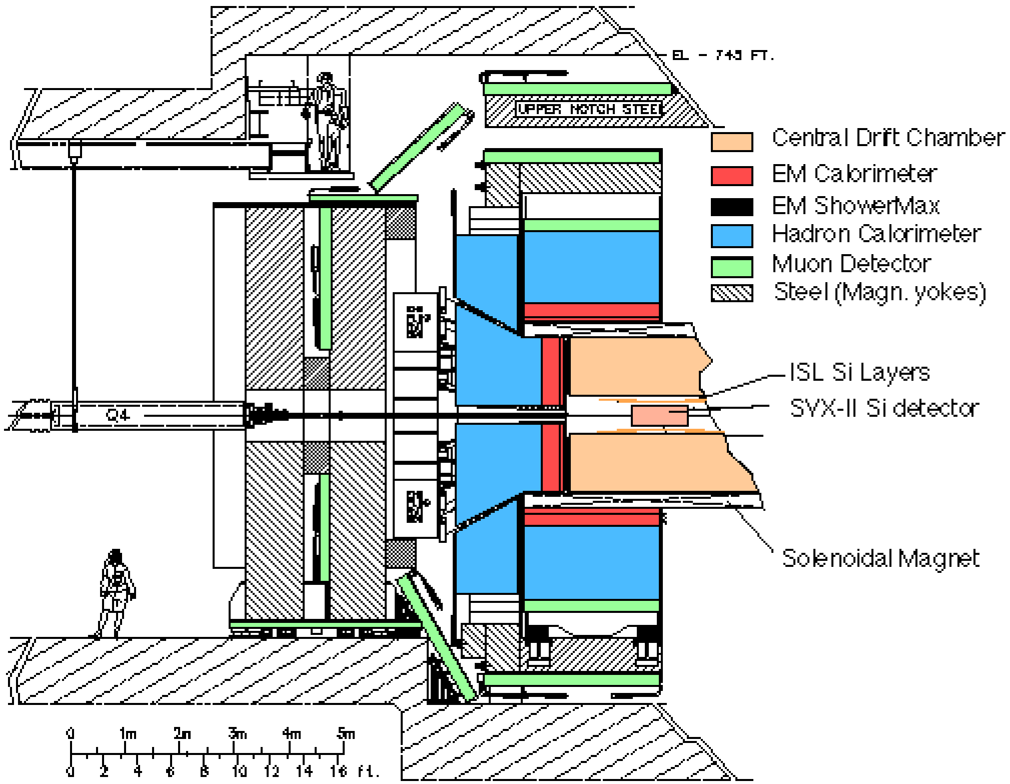
Select High-Pt Objects

Identify all high-Pt (Pt>17 GeV) and isolated (<~2 GeV) objects:

927 pb^{-1}

almost all standard (top-like) object definitions

- electron (C and P)
- muon (CMUP and CMX)
- tau (1-prong, central)
- photon (C and P)
- jet ($|\eta|<2.5$)
- b-jet (vertex tag, central)
- MEt

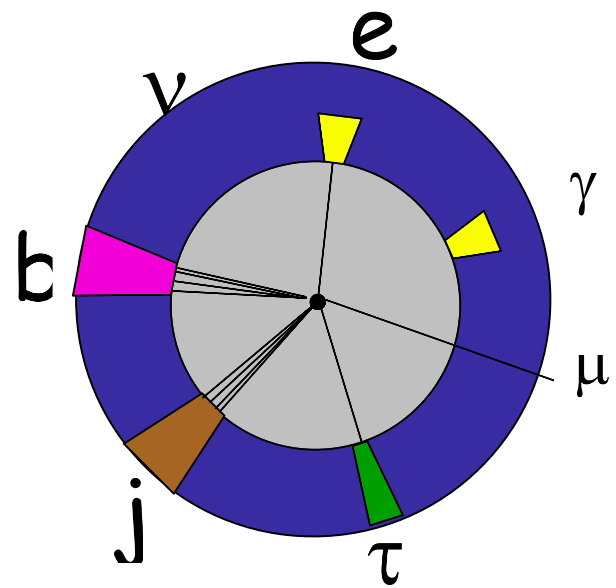


uncl = energy not in jets, photons, or leptons

SumEt = |uncl| + |identified objects Et| + |Met|

Select High-Pt Objects

- Data was collected by online triggers:
  - e, central, Et>18
  - μ, central, Pt> 18
  - γ, cen or plug, Et>25
  - jet, Et>20 (prescaled), Et>100
  - central e, Et>4, central μ, Pt>4
  - central e or μ, Et,Pt>4, plug e, Pt>8
  - γ γ, cen or plug, Et>18
  - τ τ, central, Pt>10



- Offline, reduce the sample size, require :
  - electron>25
  - OR photon>60 GeV
  - OR two leptons Et>17 GeV
  - OR jet > 200 GeV, etc
  - OR one of 10 di-object selections, some prescaled

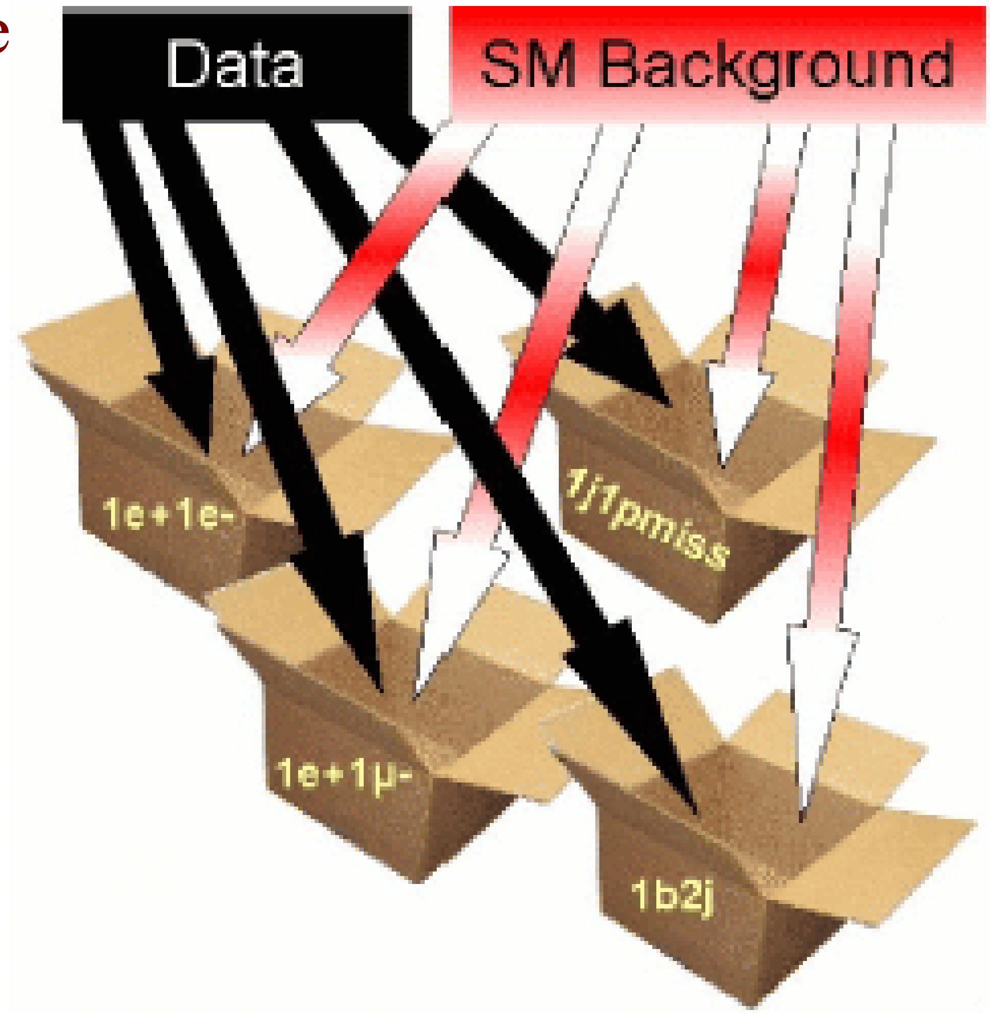
Sort by Final States

Data sorted by exclusive final state

- each identified object is exclusive
- each njet is exclusive
- require 10 events to create a new box

For all final states, histogram:

- Pt, η , ϕ of objects
- ΔR, Δϕ of pairs
- mass or m_t of subsets of particles
- other specialized variables



One Iteration of Background Model

1) Basis of all predictions is Monte Carlo
2) Allow simulation to predict fakes for high
   fake rates ($b \rightarrow j$, $\tau \rightarrow e$, etc.)
3) use explicit misidentification matrix for low fake rates:

   $j \rightarrow b, \gamma, e, \mu, \tau$

   $b \rightarrow e, \mu, \tau$

   $\gamma \rightarrow e, \mu, \tau$

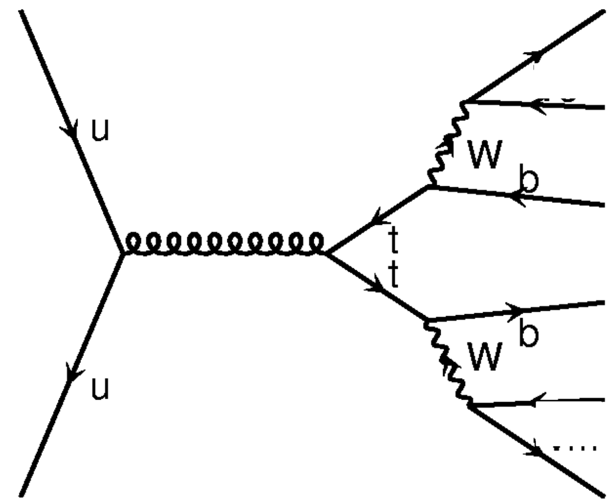
4) fit a set of correction factors to the data
5) run data/background comparisons in event counts
   for each final state and KS test for distributions

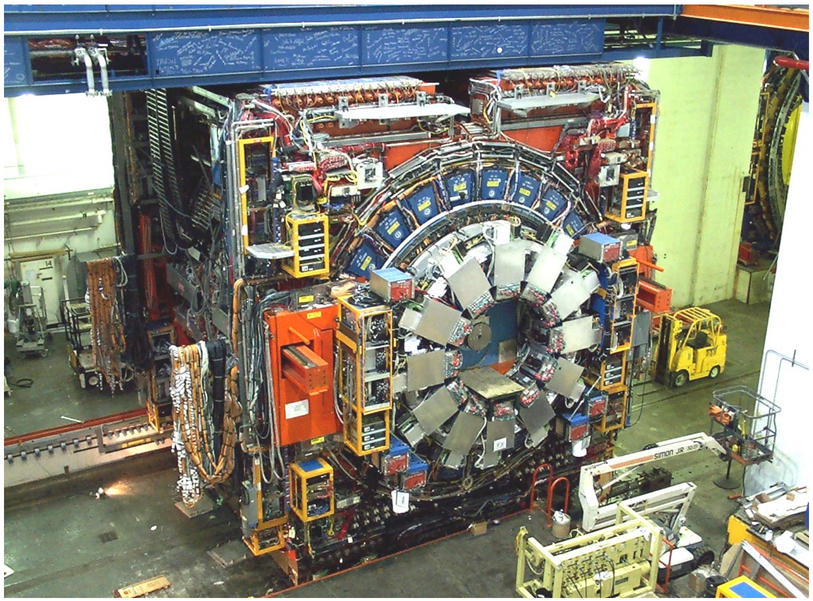
Generate the SM

- Sample definitions finely tuned to keep the sizes manageable
- coordinated with offline triggers
- often additional for high-Pt tail

- Generate most by MADEVENT plus showering from PYTHIA
- dijets, γ, γγ, VV - PYTHIA
- V+jets from Mrenna-matched MADEVENT plus showering from PYTHIA
- tt - HERWIG

- allow for pile-up, overlap events, add Kt smearing
- Pass all through the full standard CDF GEANT Simulation





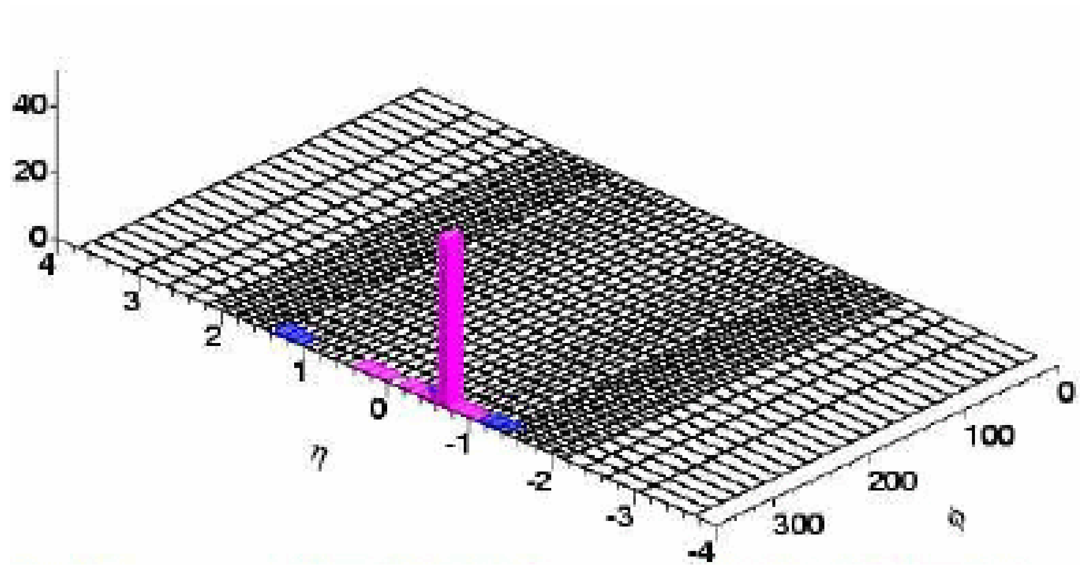
Generate non-collision backgrounds

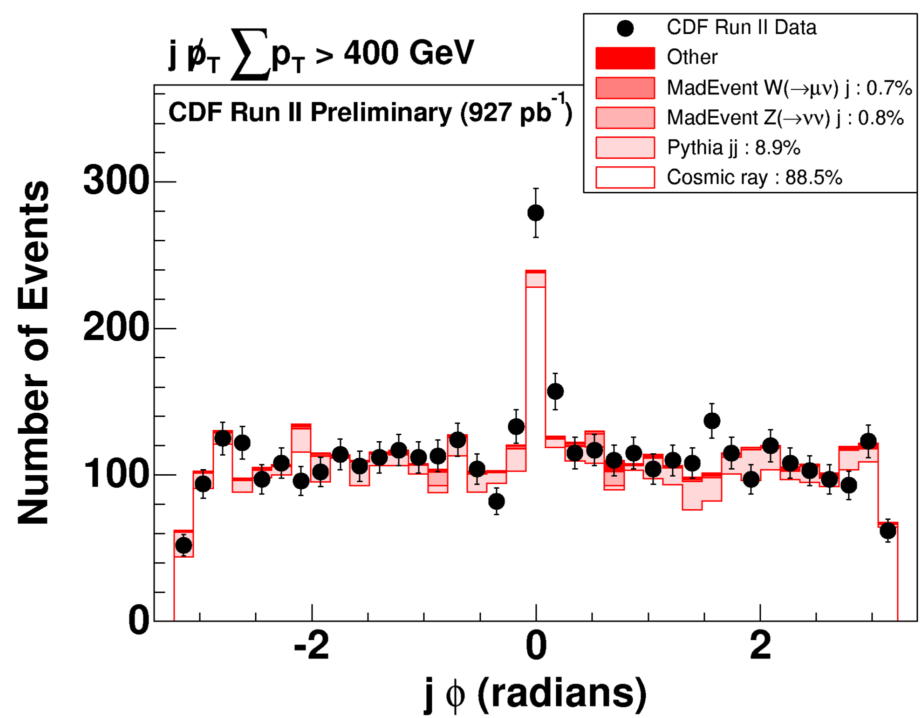
♦ beam halo muons can interact in the calorimeter

♦ cosmic ray muons can interact in the calorimeter

♦ cosmic muons causing reconstructed muons is rare

♦ model by scaling observation in events with no vertex





Fake Rate Study

- ♦ generate single isolated particles in central CDF detector
- ♦ standard simulation and reconstruction
- ♦ study rates and Et dependence

$p(\pi^0 \rightarrow \gamma)$
$p(\tau \rightarrow \gamma)$
$p(u \rightarrow \tau) / p(g \rightarrow \tau)$
$p(u \rightarrow \gamma) / p(g \rightarrow \gamma)$
$p(e+ \rightarrow \gamma) * p(\gamma \rightarrow e-)$

reconstructed

generated

	e^+	e^-	μ^+	μ^-	τ^+	τ^-	γ	j	b
e^+	62228	33	0	0	182	0	2435	28140	0
e^-	24	62324	0	0	0	192	2455	28023	1
μ^+	0	0	50491	0	6	0	0	606	0
μ^-	0	1	0	50294	0	6	0	577	0
γ	1393	1327	0	0	1	1	67679	21468	0
π^0	1204	1228	0	0	5	8	58010	33370	0
π^+	266	0	115	0	41887	6	95	54189	37
π^-	1	361	0	88	13	41355	148	54692	44
K^+	156	1	273	0	42725	7	37	52317	24
K^-	1	248	0	165	28	41562	115	53917	22
B^+	100	0	77	1	100	10	40	66062	25861
B^-	2	85	3	68	11	99	45	66414	25621
B^0	88	27	87	17	77	32	21	65866	25046
$\bar{B}^0$	17	79	11	71	41	77	21	66034	25103
D^+	126	6	62	0	1485	67	207	79596	11620
D^-	4	134	3	74	64	1400	234	79977	11554
D^0	60	13	27	2	312	1053	248	88821	5487
$\bar{D}^0$	15	46	5	28	1027	253	237	89025	5480
K_L^0	1	4	0	0	71	60	202	96089	26
K_S^0	26	31	2	1	170	525	9715	76196	0
τ^+	1711	13	1449	0	4167	2	673	50866	607
τ^-	12	1716	0	1474	6	3940	621	51125	580
u	8	10	1	0	446	31	247	94074	26
d	3	4	0	0	64	308	191	94322	22
g	2	0	0	0	17	14	12	81865	99

$/10^5$

Fake Rates

Primary fake mechanisms:

$j \rightarrow e$

$j \rightarrow q \rightarrow \pi^0 \rightarrow \gamma\gamma \rightarrow \gamma ee \rightarrow e$

$j \rightarrow \mu$

$j \rightarrow q \rightarrow \pi^+ \rightarrow \mu\nu \rightarrow \mu$

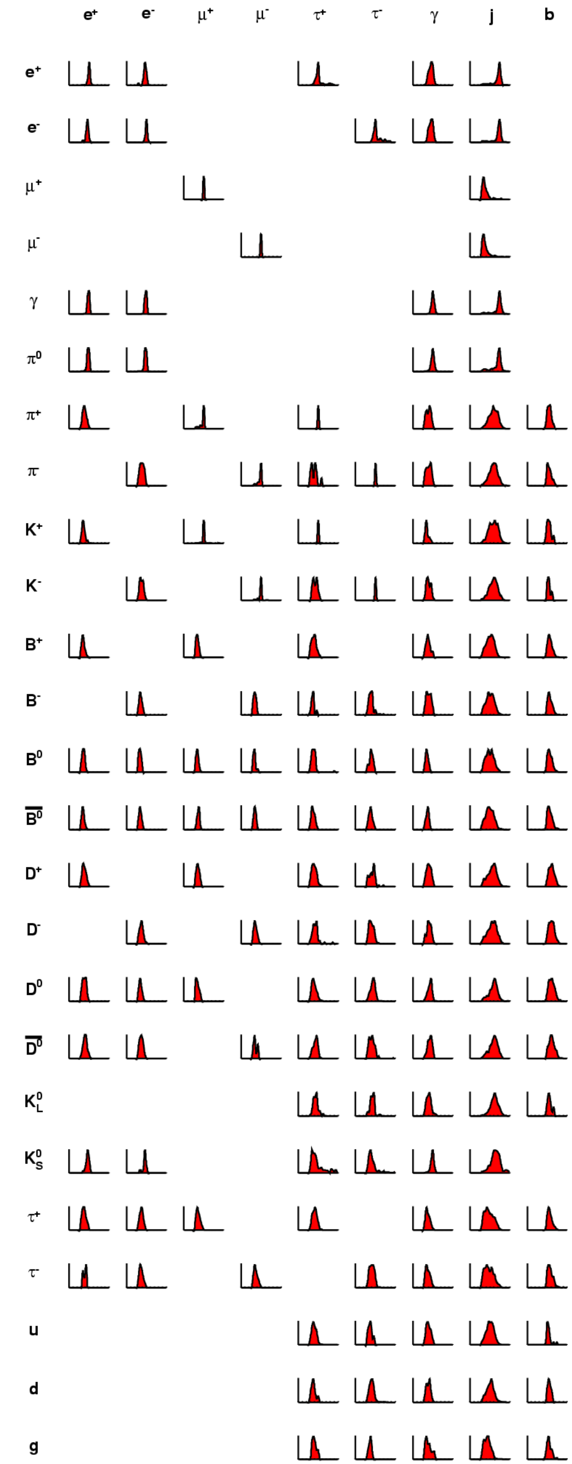
$j \rightarrow \tau$

$j \rightarrow q \rightarrow \pi^+ \rightarrow \tau$

$j \rightarrow \gamma$

$j \rightarrow q \rightarrow \pi^0 \rightarrow \gamma\gamma \rightarrow \gamma$

everything depends on $j \rightarrow q \rightarrow \pi$



Explicit MisID matrix

- handles low-rate fakes and tweak high-rate fake rates
- form jets from generator info
- from fake rate study
  - define model (quarks *vs* gluons)
  - modify energy (only 95% of q energy goes into a fake electron)

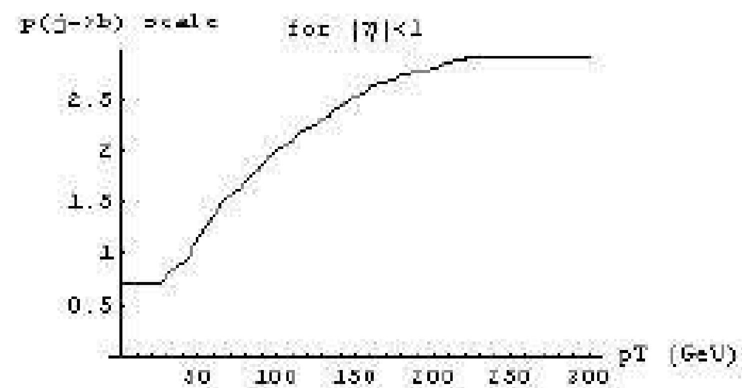
- Some values fixed, some modified in the next step (fit)

- Some explicit energy dependence $j \rightarrow b$, $j \rightarrow e$ (plug), $j \rightarrow \tau$ and ϕ dependence for muon fakes

(mis)Id

true

	e	μ	τ	γ	j	b
e	0.66		2e-3	0.02	0.28	
μ		0.51				
τ	0.02	0.01	0.04		0.90	6e-3
γ	0.03			0.68	0.21	
j	1e-4	1e-5	3e-3	3e-4	1	2e-2
b	1e-4	1e-4	1e-4	5e-5	0.65	0.35



Fit Correction Factors

- correction categories:
  - 16 fake rates
  - luminosity
  - 4 efficiencies
  - 23 k-factors
- fit 44 parameters in all
  to wide bins in η, Pt for all final states
- introduced only as necessary, simple well, motivated
- constraints applied when available
  - W NNLO x-sec, etc.
  - CDF b-tag efficiency , etc.

CDF Run II Preliminary (927 pb^{-1})

Code	Description	Value	σ_{fit}	$\mu_{constraint}$	$\sigma_{constraint}$	$\frac{value-\mu}{\sigma_{constraint}}$
5001	luminosity	927.1	20	901.9	53.11	0.47
5161	k-factor, 2j $\hat{p}_T < 150$	0.96	0.02	1.100	0.050	-2.8
5162	k-factor, 2j $150 < \hat{p}_T$	1.26	0.03	1.330	0.050	-1.4
5211	misId, $p(e \to e)$ central	0.99	0.01	0.981	0.007	1.29
5212	misId, $p(e \to e)$ plug	0.93	0.01	0.940	0.010	-1
5216	misId, $p(\gamma \to \gamma)$ central	0.97	0.02	0.990	0.020	-1
5217	misId, $p(\gamma \to \gamma)$ plug	0.91	0.02	0.910	0.020	0
5219	misId, $p(b \to b)$ central	1	0.04	0.874	0.080	1.58
5285	misId, $p(q \to \tau) 15 < \hat{p}_T < 60$	3.4×10^{-3}	1.0×10^{-4}	0.004	0.0004	-1.5
5401	trigger, $p(e \to trig)$ central, $\hat{p}_T > 25$	0.98	0.01	0.970	0.010	1
5403	trigger , $p(\mu \to trig)$ CMUP, $\hat{p}_T > 25$	0.92	0.01	0.908	0.010	1.2
5404	trigger , $p(\mu \to trig)$ CMX, $\hat{p}_T > 25$	0.96	0.01	0.954	0.015	0.4

Fit Correction Factors

♦Many can be identified with single final states

♦ $\chi 2$ = 288/133+27

CDF Run II Preliminary (927 pb^{-1})

Code	Category	Explanation	Value	Error	Error(%)
5001	luminosity	CDF integrated luminosity	927.1	20	2.2
5102	k-factor	cosmic_ph	0.686	0.05	7.3
5103	k-factor	cosmic_j	0.4464	0.014	3.1
5121	k-factor	$1\gamma 1j$ photon+jet(s)	0.9492	0.04	4.2
5122	k-factor	$1\gamma 2j$	1.205	0.05	4.1
5123	k-factor	$1\gamma 3j$	1.483	0.07	4.7
5124	k-factor	$1\gamma 4j+$	1.968	0.16	8.1
5130	k-factor	$2\gamma 0j$ diphoton(+jets)	1.809	0.08	4.4
5131	k-factor	$2\gamma 1j$	3.417	0.24	7.0
5132	k-factor	$2\gamma 2j+$	1.305	0.16	12.3
5141	k-factor	W0j W (+jets)	1.453	0.027	1.9
5142	k-factor	W1j	1.059	0.03	2.8
5143	k-factor	W2j	1.021	0.03	2.9
5144	k-factor	W3j+	0.7582	0.05	6.6
5151	k-factor	Z0j Z (+jets)	1.419	0.024	1.7
5152	k-factor	Z1j	1.177	0.04	3.4
5153	k-factor	Z2j+	1.035	0.05	4.8
5161	k-factor	2j $\hat{p}_T<150$ dijet	0.9599	0.022	2.3
5162	k-factor	2j $150<\hat{p}_T$	1.256	0.028	2.2
5164	k-factor	3j $\hat{p}_T<150$ multijet	0.9206	0.021	2.3
5165	k-factor	3j $150<\hat{p}_T$	1.36	0.032	2.4
5167	k-factor	4j $\hat{p}_T<150$	0.9893	0.025	2.5
5168	k-factor	4j $150<\hat{p}_T$	1.705	0.04	2.3
5169	k-factor	5j+ low	1.252	0.05	4.0
5211	misId	$p(e\rightarrow e)$ central	0.9864	0.006	0.6
5212	misId	$p(e\rightarrow e)$ plug	0.9334	0.009	1.0
5213	misId	$p(\mu\rightarrow\mu)$ CMUP	0.8451	0.008	0.9
5214	misId	$p(\mu\rightarrow\mu)$ CMX	0.915	0.011	1.2
5216	misId	$p(\gamma\rightarrow\gamma)$ central	0.9738	0.018	1.8
5217	misId	$p(\gamma\rightarrow\gamma)$ plug	0.9131	0.018	2.0
5219	misId	$p(b\rightarrow b)$ central	0.9969	0.04	4.0
5245	misId	$p(e\rightarrow\gamma)$ plug	0.04452	0.012	27.0
5256	misId	$p(q\rightarrow e)$ central	9.71×10^{-5}	1.9×10^{-6}	2.0
5257	misId	$p(q\rightarrow e)$ plug	0.0008761	1.8×10^{-5}	2.1
5261	misId	$p(q\rightarrow\mu)$	1.157×10^{-5}	2.7×10^{-7}	2.3
5273	misId	$p(j\rightarrow b)$ $25<p_T$	0.01684	0.00027	1.6
5285	misId	$p(q\rightarrow\tau)$ $15<p_T<60$	0.003414	0.00012	3.5
5286	misId	$p(q\rightarrow\tau)$ $60<p_T<200$	0.000381	4×10^{-5}	10.5
5292	misId	$p(q\rightarrow\gamma)$ central	0.0002651	1.5×10^{-5}	5.7
5293	misId	$p(q\rightarrow\gamma)$ plug	0.001591	0.00013	8.2
5401	trigger	$p(e\rightarrow trig)$ central, $p_T>25$	0.9758	0.007	0.7
5402	trigger	$p(e\rightarrow trig)$ plug, $p_T>25$	0.835	0.015	1.8
5403	trigger	$p(\mu\rightarrow trig)$ CMUP, $p_T>25$	0.9166	0.007	0.8
5404	trigger	$p(\mu\rightarrow trig)$ CMX, $p_T>25$	0.9613	0.01	1.0

Debugging Vignette

- ♦ simple, well-motivated
- ♦ consult with experts
- ♦ excess in e-μ final state

-observe excess in plug

-split p(j→e) into central and plug

-poor stats in plug –

add photon trigger

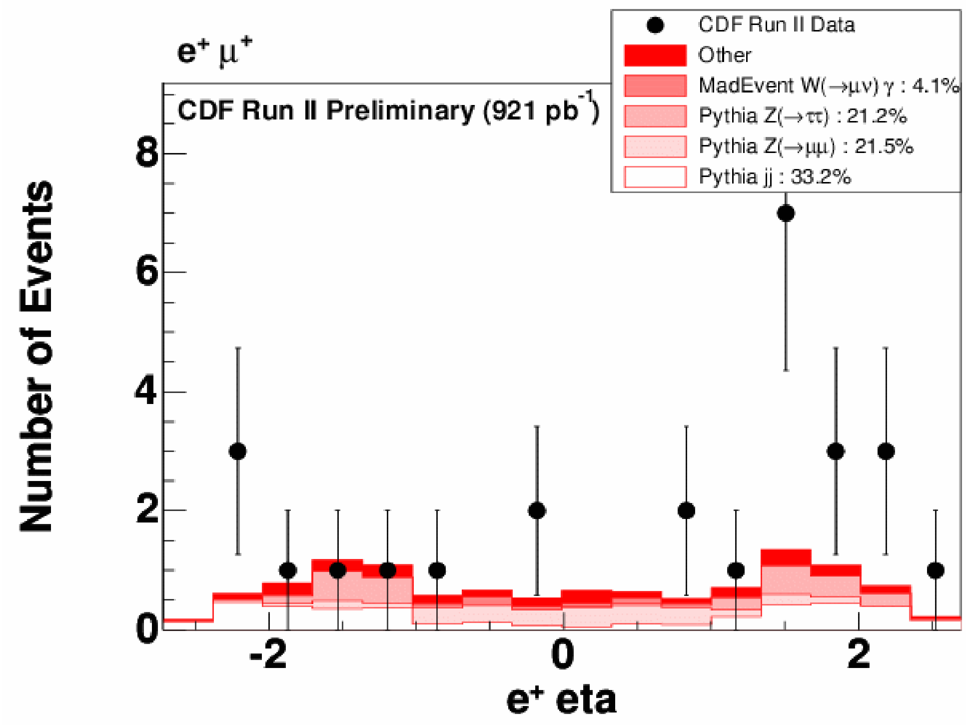
-fit returns a large χ2

-tension between e-Met, ej and ejj

-further investigations revealed

central and plug trigger differences

-split central and plug trigger eff.

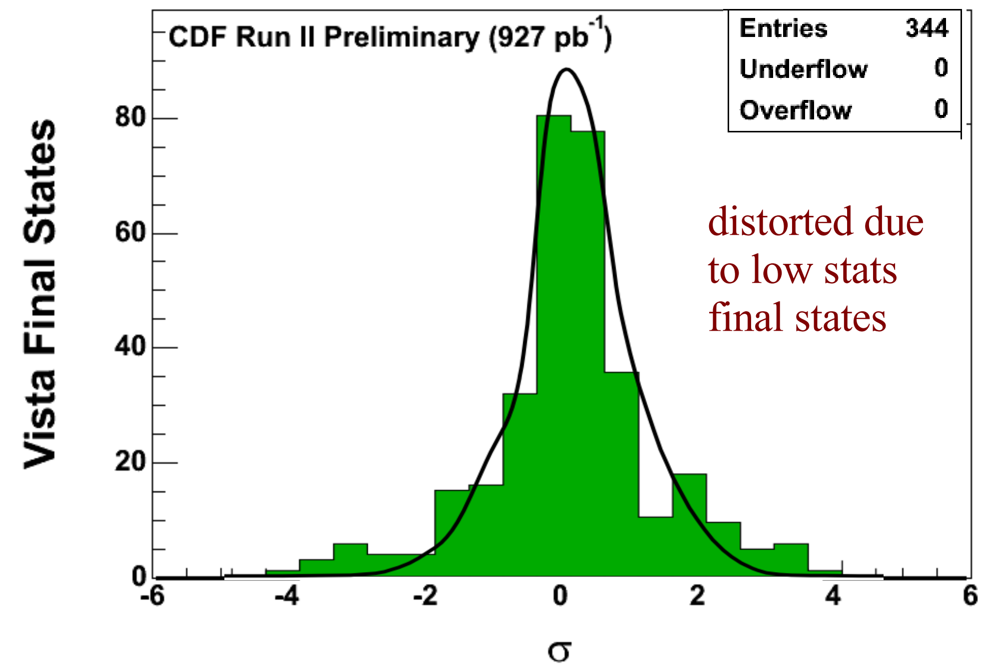


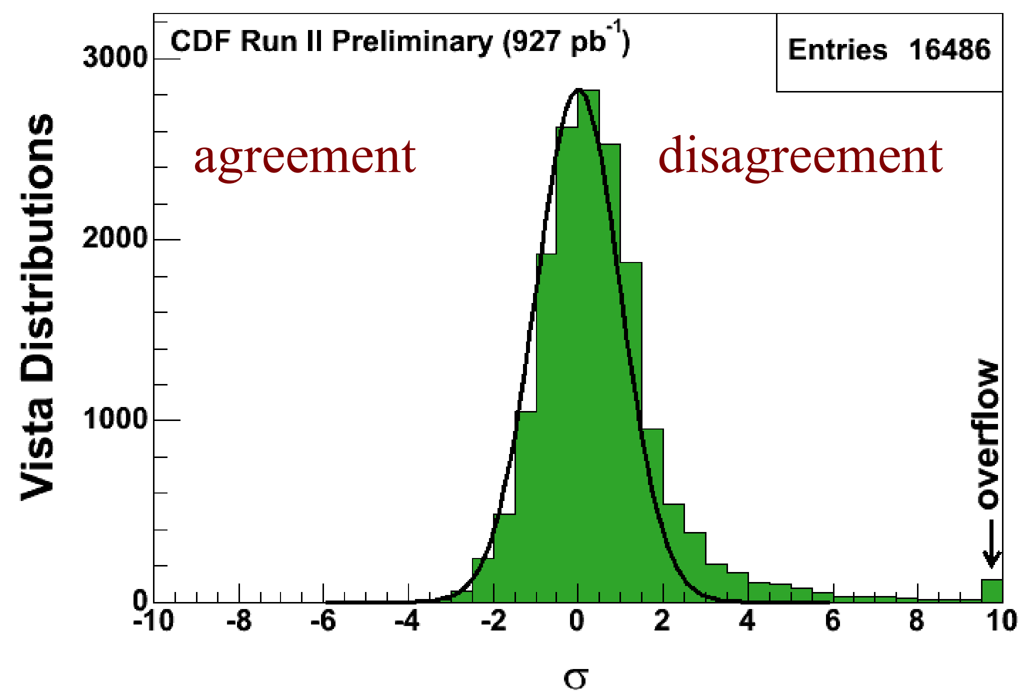
Vista Results

- Vista produces
  - 344 final states
  - 16K kinematic distributions
  - sorted by discrepancy

- no normalization excesses
- reasonable agreement virtually everywhere

Remaining effects on tails do not hint at new physics





Vista Final States

-344

-trials factor included

Final State	Data	Background
$3j\tau+$	71	113.7 ± 3.6
$5j$	1661	1902.9 ± 50.8
$2j\tau+$	233	296.5 ± 5.6
$be+j$	2207	2015.4 ± 28.7
$3j$ $\Sigma p_T < 400$ GeV	35436	37294.6 ± 524.3
$e+3j\not{p}$	1954	1751.6 ± 42
$be+2j$	798	695.3 ± 13.3
$3j\not{p}$ $\Sigma p_T > 400$ GeV	811	967.5 ± 38.4
$e+\mu+$	26	11.6 ± 1.5
$e+\gamma$	636	551.2 ± 11.2
$e+3j$	28656	27281.5 ± 405.2
$b5j$	131	95 ± 4.7
$j2\tau+$	50	85.6 ± 8.2
$j\tau+\tau-$	74	125 ± 13.6
$b\not{p}$ $\Sigma p_T > 400$ GeV	10	29.5 ± 4.6
$e+j\gamma$	286	369.4 ± 21.1
$e+j\not{p}\tau-$	29	14.2 ± 1.8
$2j$ $\Sigma p_T < 400$ GeV	96502	92437.3 ± 1354.5
$be+3j$	356	298.6 ± 7.7
$8j$	11	6.1 ± 2.5
$7j$	57	35.6 ± 4.9
$6j$	335	298.4 ± 14.7
$4j$ $\Sigma p_T > 400$ GeV	39665	40898.8 ± 649.2
$4j$ $\Sigma p_T < 400$ GeV	8241	8403.7 ± 144.7
$4j2\gamma$	38	57.5 ± 11
$4j\tau+$	20	36.9 ± 2.4
$4j\not{p}$ $\Sigma p_T > 400$ GeV	516	525.2 ± 34.5
$4j\gamma\not{p}$	28	53.8 ± 11
$4j\gamma$	3693	3827.2 ± 112.1
$4j\mu+$	576	568.2 ± 26.1
$4j\mu+\not{p}$	232	224.7 ± 8.5
$4j\mu+\mu-$	17	20.1 ± 2.5
3γ	13	24.2 ± 3
$3j$ $\Sigma p_T > 400$ GeV	75894	75939.2 ± 1043.9
$3j2\gamma$	145	178.1 ± 7.4
$3j\not{p}$ $\Sigma p_T < 400$ GeV	20	30.9 ± 14.4
$3j\gamma\tau+$	13	11 ± 2
$3j\gamma\not{p}$	83	102.9 ± 11.1
$3j\gamma$	11424	11506.4 ± 190.6
$3j\mu+\not{p}$	1114	1118.7 ± 27.1
$3j\mu+\mu-$	61	84.5 ± 9.2
$3j\mu+$	2132	2168.7 ± 64.2
$3bj$ $\Sigma p_T > 400$ GeV	14	9.3 ± 1.9
$2\tau+$	316	290.8 ± 24.2
$2\gamma\not{p}$	161	176 ± 9.1
2γ	8482	8349.1 ± 84.1
$2j$ $\Sigma p_T > 400$ GeV	93408	92789.5 ± 1138.2
$2j2\gamma$	645	612.6 ± 18.8
$2j\tau+\tau-$	15	25 ± 3.5
$2j\not{p}$ $\Sigma p_T > 400$ GeV	74	106 ± 7.8
$2j\not{p}$ $\Sigma p_T < 400$ GeV	43	37.7 ± 100.2
$2j\gamma$	33684	33259.9 ± 397.6
$2j\gamma\tau+$	48	41.4 ± 3.4
$2j\gamma\not{p}$	403	425.2 ± 29.7
$2j\mu+\not{p}$	7287	7320.5 ± 118.9
$2j\mu+\gamma\not{p}$	13	12.6 ± 2.7
$2j\mu+\gamma$	41	35.7 ± 6.1
$2j\mu+\mu-$	374	394.2 ± 24.8
$2j\mu+$	9513	9362.3 ± 166.8

Final State	Data	Background
$2e+j$	13	9.8 ± 2.2
$2e+e-$	12	4.8 ± 1.2
$2e+$	23	36.1 ± 3.8
$2b$ $\Sigma p_T > 400$ GeV	327	335.8 ± 7
$2b$ $\Sigma p_T < 400$ GeV	187	173.1 ± 7.1
$2b3j$ $\Sigma p_T < 400$ GeV	28	33.5 ± 5.5
$2b2j$ $\Sigma p_T > 400$ GeV	355	326.3 ± 8.4
$2b2j$ $\Sigma p_T < 400$ GeV	56	80.2 ± 5
$2b2j\gamma$	16	15.4 ± 3.6
$2b\gamma$	37	31.7 ± 4.8
$2bj$ $\Sigma p_T > 400$ GeV	415	393.8 ± 9.1
$2bj$ $\Sigma p_T < 400$ GeV	161	195.8 ± 8.3
$2bj\not{p}$ $\Sigma p_T > 400$ GeV	28	23.2 ± 2.6
$2bj\gamma$	25	24.7 ± 4.3
$2be+2j\not{p}$	15	12.3 ± 1.6
$2be+2j$	30	30.5 ± 2.5
$2be+j$	28	29.1 ± 2.8
$2be+$	48	45.2 ± 3.7
$\tau+\tau-$	498	428.5 ± 22.7
$\gamma\tau+$	177	204.4 ± 5.4
$\gamma\not{p}$	1952	1945.8 ± 77.1
$\mu+\tau+$	18	19.8 ± 2.3
$\mu+\tau-$	151	179.1 ± 4.7
$\mu+\not{p}$	321351	320500 ± 3475.5
$\mu+\not{p}\tau-$	22	25.8 ± 2.7
$\mu+\gamma$	269	285.5 ± 5.9
$\mu+\gamma\not{p}$	269	282.2 ± 6.6
$\mu+\mu-\not{p}$	49	61.4 ± 3.5
$\mu+\mu-\gamma$	32	29.9 ± 2.6
$\mu+\mu-$	10648	10845.6 ± 96
$j2\gamma$	2196	2200.3 ± 35.2
$j2\gamma\not{p}$	38	27.3 ± 3.2
$j\tau+$	563	585.7 ± 10.2
$j\not{p}$ $\Sigma p_T > 400$ GeV	4183	4209.1 ± 56.1
$j\gamma$	49052	48743 ± 546.3
$j\gamma\tau+$	106	104 ± 4.1
$j\gamma\not{p}$	913	965.2 ± 41.5
$j\mu+$	33462	34026.7 ± 510.1
$j\mu+\tau-$	29	37.5 ± 4.5
$j\mu+\not{p}\tau-$	10	9.6 ± 2.1
$j\mu+\not{p}$	45728	46316.4 ± 568.2
$j\mu+\gamma\not{p}$	78	69.8 ± 9.9
$j\mu+\gamma$	70	98.4 ± 12.1
$j\mu+\mu-$	1977	2093.3 ± 74.7
$e+4j$	7144	6661.9 ± 147.2
$e+4j\not{p}$	403	363 ± 9.9
$e+3j\tau-$	11	7.6 ± 1.6
$e+3j\gamma$	27	21.7 ± 3.4
$e+2\gamma$	47	74.5 ± 5
$e+2j$	126665	122457 ± 1672.6
$e+2j\tau-$	53	37.3 ± 3.9
$e+2j\tau+$	20	24.7 ± 2.3
$e+2j\not{p}$	12451	12130.1 ± 159.4
$e+2j\gamma$	101	88.9 ± 6.1
$e+\tau-$	609	555.9 ± 10.2
$e+\tau+$	225	211.2 ± 4.7
$e+\not{p}$	476424	479572 ± 5361.2
$e+\not{p}\tau-$	48	35 ± 2.7
$e+\not{p}\tau+$	20	18.7 ± 1.9

Final State	Data	Background
$e+\gamma\not{p}$	141	144.2 ± 6
$e+\mu-\not{p}$	54	42.6 ± 2.7
$e+\mu+\not{p}$	13	10.9 ± 1.3
$e+\mu-$	153	127.6 ± 4.2
$e+j$	386880	392614 ± 5031.8
$e+j2\gamma$	14	15.9 ± 2.9
$e+j\tau+$	79	79.3 ± 2.9
$e+j\tau-$	162	148.8 ± 7.6
$e+j\not{p}$	58648	57391.7 ± 661.6
$e+j\gamma\not{p}$	52	76.2 ± 9
$e+j\mu-\not{p}$	22	13.1 ± 1.7
$e+j\mu-$	28	26.8 ± 2.3
$e+e-4j$	103	113.5 ± 5.9
$e+e-3j$	456	473 ± 14.6
$e+e-2j\not{p}$	30	39 ± 4.6
$e+e-2j$	2149	2152 ± 40.1
$e+e-\tau+$	14	11.1 ± 2
$e+e-\not{p}$	491	487.9 ± 12
$e+e-\gamma$	127	132.3 ± 4.2
$e+e-j$	10726	10669.3 ± 123.5
$e+e-j\not{p}$	157	144 ± 11.2
$e+e-j\gamma$	26	45.6 ± 4.7
$e+e-$	58344	58575.6 ± 603.9
$b6j$	24	15.5 ± 2.3
$b4j$ $\Sigma p_T > 400$ GeV	13	9.2 ± 1.8
$b4j$ $\Sigma p_T < 400$ GeV	464	499.2 ± 12.4
$b3j$ $\Sigma p_T > 400$ GeV	5354	5285 ± 72.4
$b3j$ $\Sigma p_T < 400$ GeV	1639	1558.9 ± 24.1
$b3j\not{p}$ $\Sigma p_T > 400$ GeV	111	116.8 ± 11.2
$b3j\gamma$	182	194.1 ± 8.8
$b3j\mu+\not{p}$	37	34.1 ± 2
$b3j\mu+$	47	52.2 ± 3
$b2\gamma$	15	14.6 ± 2.1
$b2j$ $\Sigma p_T > 400$ GeV	8812	8576.2 ± 97.9
$b2j$ $\Sigma p_T < 400$ GeV	4691	4646.2 ± 57.7
$b2j\not{p}$ $\Sigma p_T > 400$ GeV	198	209.2 ± 8.3
$b2j\gamma$	429	425.1 ± 13.1
$b2j\mu+\not{p}$	46	40.1 ± 2.7
$b2j\mu+$	56	60.6 ± 3.4
$b\tau+$	19	19.9 ± 2.2
$b\gamma$	976	1034.8 ± 15.6
$b\gamma\not{p}$	18	16.7 ± 3.1
$b\mu+$	303	263.5 ± 7.9
$b\mu+\not{p}$	204	218.1 ± 6.4
bj $\Sigma p_T > 400$ GeV	9060	9275.7 ± 87.8
bj $\Sigma p_T < 400$ GeV	7236	7030.8 ± 74
$bj2\gamma$	13	17.6 ± 3.3
$bj\tau+$	13	12.9 ± 1.8
$bj\not{p}$ $\Sigma p_T > 400$ GeV	53	60.4 ± 19.9
$bj\gamma$	937	989.4 ± 20.6
$bj\gamma\not{p}$	34	30.5 ± 4
$bj\mu+\not{p}$	104	112.6 ± 4.4
$bj\mu+$	173	141.4 ± 4.8
$be+3j\not{p}$	68	52.2 ± 2.2
$be+2j\not{p}$	87	65 ± 3.3
$be+\not{p}$	330	347.2 ± 6.9
$be+j\not{p}$	211	176.6 ± 5
$be+e-j$	22	34.6 ± 2.6
$be+e-$	62	55 ± 3.1

Vista

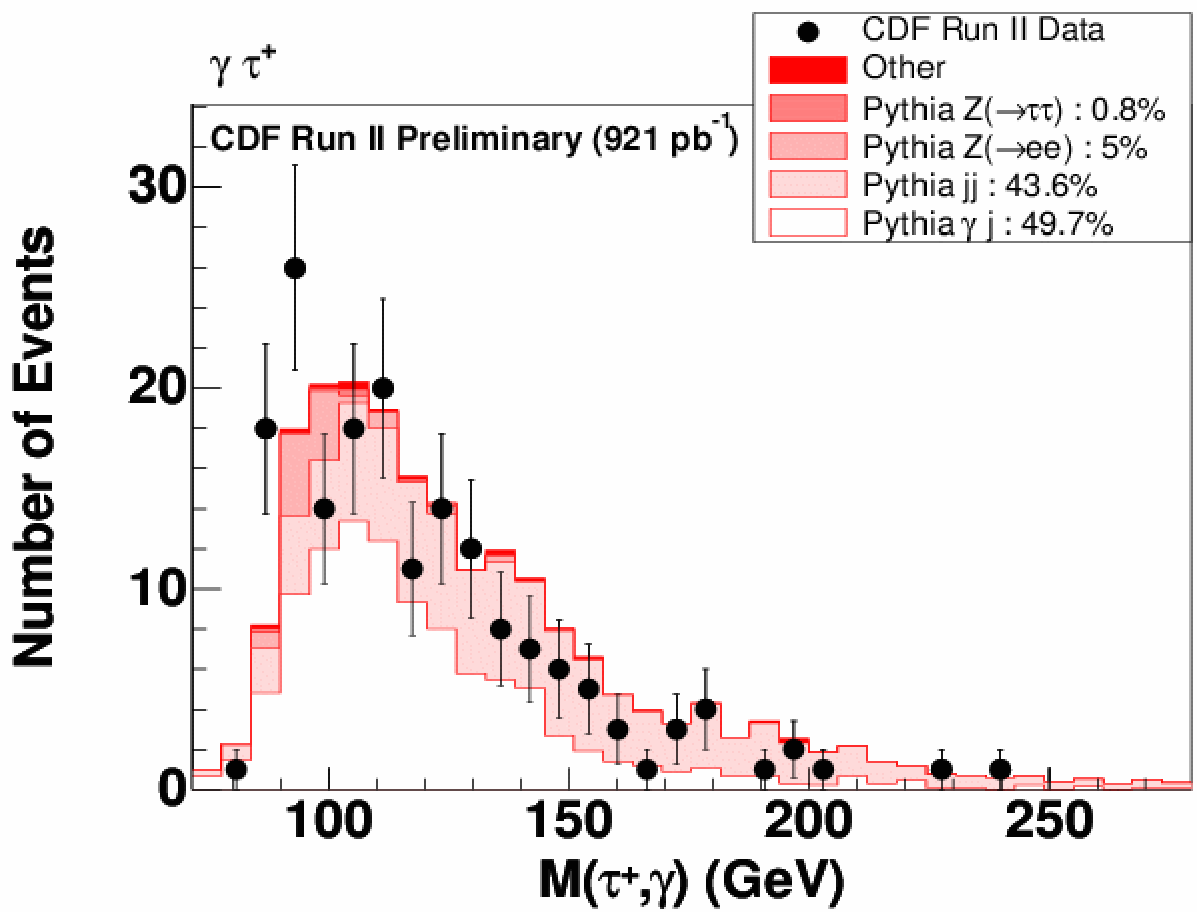
Table of final states

Final State	Plots	Observed	Expected	Discrepancy (σ)	SM composition	Discrepant Distributions (σ)
3j1tau+	[plots]	71	113.7 +- 3.6	-2.3	Pythia jj 40 < pT < 60 = 27.5, Pythia jj 60 < pT < 90 = 18.2, Pythia jj 18 < pT < 40 = 17.8, Pythia jj 200 < pT < 300 = 17.7, Pythia jj 150 < pT < 200 = 15.7, Pythia jj 90 < pT < 120 = 6.8, Pythia jj 120 < pT < 150 = 3.8, Pythia bj 40 < pT < 60 = 1.4, Pythia jj 300 < pT < 400 = 1.3, Pythia bj 60 < pT < 90 = 1, Pythia bj 200 < pT < 300 = 0.7, Pythia bj 150 < pT < 200 = 0.4, Pythia bj 18 < pT < 40 = 0.3, Pythia gamma j 80 < pT = 0.2, Pythia bj 120 < pT < 150 = 0.2, Pythia bj 90 < pT < 120 = 0.1, Pythia gamma j 22 < pT < 45 = 0.1	
5j	[plots]	1661	1902.9 +- 50.8	-1.7	Pythia jj 40 < pT < 60 = 685.8, Pythia jj 18 < pT < 40 = 553.4, Pythia jj 60 < pT < 90 = 429.9, Pythia jj 90 < pT < 120 = 98.8, Pythia bj 40 < pT < 60 = 41.2, Pythia bj 60 < pT < 90 = 28.2, Pythia bj 18 < pT < 40 = 27, Pythia jj 120 < pT < 150 = 17.4, Pythia jj 150 < pT < 200 = 6.4, Pythia bj 90 < pT < 120 = 6.1, Overlaid events = 5.5, Pythia bj 120 < pT < 150 = 1.2, Pythia bj 150 < pT < 200 = 0.7, MadEvent W(→eν) jjjj = 0.5, Pythia jj 200 < pT < 300 = 0.5, Herwig ttbar = 0.2	mass(j2)/j2_pt 7.1 mass(j1) 6.7 mass(j3)/j3_pt 6.2 mass(j2,j3) 4.4 mass(j2,j3,j4) 4.2 mass(j1)/j1_pt 3.9 mass(j2,j3,j5) 3.5 deltaR(j2,j3) 3.4 mass(j2,j3,j4,j5) 3.3 mass(j2) 2.8 mass(j4)/j4_pt 2.5
2j1tau+	[plots]	233	296.5 +- 5.6	-1.6	Pythia jj 40 < pT < 60 = 95.9, Pythia jj 18 < pT < 40 = 67.3, Pythia jj 60 < pT < 90 = 54.3, Pythia jj 200 < pT < 300 = 30.9, Pythia jj 150 < pT < 200 = 19.6, Pythia jj 90 < pT < 120 = 10.8, Pythia jj 120 < pT < 150 = 5.4, Pythia bj 40 < pT < 60 = 4, Pythia jj 300 < pT < 400 = 2, Pythia bj 18 < pT < 40 = 1.6, Pythia bj 60 < pT < 90 = 1.5, Pythia bj 200 < pT < 300 = 0.8, Pythia bj 150 < pT < 200 = 0.5, Pythia bj 90 < pT < 120 = 0.4, Pythia Z(→τ τ) = 0.3, Pythia gamma j 80 < pT = 0.3, MadEvent Z(→ee) j = 0.1, Pythia gamma j 22 < pT < 45 = 0.1, Pythia bj 120 < pT < 150 = 0.1	mass(tau+,j1,j2) 3.7 sumPt 3.5 mass(tau+,j2) 3 mass(tau+,j1) 2.7 clusteredObjectsRecoil_pt 2.6 j1_pt 2.5
2j2tau+	[plots]	6	27 +- 4.6	-1.4	Pythia jj 18 < pT < 40 = 11.7, Pythia jj 40 < pT < 60 = 9.5, Pythia jj 60 < pT < 90 = 4.1, Pythia bj 40 < pT < 60 = 0.8, Pythia jj 90 < pT < 120 = 0.7, Pythia bj 18 < pT < 40 = 0.1	
1b1e+1j	[plots]	2207	2015.4 +- 28.7	+1.4	Pythia jj 40 < pT < 60 = 411.6, Pythia bj 40 < pT < 60 = 295.7, Pythia jj 60 < pT < 90 = 233.5, Pythia jj 18 < pT < 40 = 225.5, Pythia bj 18 < pT < 40 = 162.8, Pythia bj 60 < pT < 90 = 155.8, MadEvent W(→eν) jj = 91.4, Pythia gamma j 22 < pT < 45 = 79.7, MadEvent Z(→ee) j = 74.4, Pythia jj 90 < pT < 120 = 55.5, Pythia gamma j 45 < pT < 80 = 27.5, Pythia bj 90 < pT < 120 = 26.6, Pythia gamma j 12 < pT < 22 = 26.5, MadEvent Z(→ee) jj = 23.4, Alpgen W(→eν) bb = 13.3, MadEvent W(→eν) j = 12.4, Pythia jj 120 < pT < 150 = 11.6, Pythia gamma j 80 < pT = 10.4, MadEvent W(→eν) jjj = 10.4, MadEvent Z(→ee) = 9.6, Alpgen W(→eν) bb j = 8.8, Pythia W(→τ ν) = 8.8, Pythia jj 150 < pT < 200 = 7.5, Herwig ttbar = 5.1, MadEvent Z(→ee) gamma = 4.8, Pythia bj 120 < pT < 150 = 4.5, MadEvent Z(→ee) bb = 4.1, MadEvent Z(→ee) jjj = 2.9, Alpgen W(→eν) bb jj = 2.1, Pythia bj 150 < pT < 200 = 1.8, Pythia jj 200 < pT < 300 = 1.5, MadEvent W(→eν) jjjj = 1.1, MadEvent W(→eν) gamma = 0.8, Overlaid events = 0.8, MadEvent W(→eν) = 0.6, Pythia bj 10 < pT < 18 = 0.6, Pythia ZZ = 0.5, MadEvent gamma gamma jj = 0.3, Pythia bj 200 < pT < 300 = 0.3, Pythia Z(→τ τ) = 0.3, Pythia WZ = 0.2	mass(b)/b_pt 9.9 mass(b) 7.2 mass(j)/j_pt 4.3 deltaR(j,b) 4.1 minMass(j) 3.9 mass(j,b) 3.6 uncl_pt 3.5
3j_sumPt0-400	[plots]	35436	37294.6 +- 524.3	-1.1	Pythia jj 18 < pT < 40 = 18129.1, Pythia jj 40 < pT < 60 = 12273.7, Pythia jj 60 < pT < 90 = 3950.7, Pythia bj 18 < pT < 40 = 751.6, Pythia jj 10 < pT < 18 = 749, Pythia bj 40 < pT < 60 = 540.5, Pythia jj 90 < pT < 120 = 520.8, Pythia bj 60 < pT < 90 = 179.5, Pythia jj 120 < pT < 150 = 96.7, Pythia jj 150 < pT < 200 = 27.6, Pythia bj 90 < pT < 120 = 19.7, Pythia gamma j 22 < pT < 45 = 13.8, Pythia bj 10 < pT < 18 = 13.8, Overlaid events = 7.9, Pythia gamma j 12 < pT < 22 = 7.9, MadEvent Z(→ee) jj = 3.9, Pythia gamma j 8 < pT < 12 = 2, Pythia bj 120 < pT < 150 = 2, MadEvent W(→eν) jjj = 2, MadEvent W(→eν) jjjj = 2	minDeltaR(j,j) 9.9 mass(j2,j3) 9.9 deltaR(j2,j3) 9.9 deltaEta(j2,j3) 9.9 mass(j2)/j2_pt 9.9
1e+3j1pmiss	[plots]	1954	1751.6 +- 42	+1.1	MadEvent W(→eν) jj = 705.6, MadEvent W(→eν) jjj = 595.3, MadEvent W(→eν) j = 132.6, MadEvent W(→eν) jjjj = 85, Pythia W(→τ ν) = 56.4, MadEvent W(→eν) = 45.8, Herwig ttbar = 26.7, MadEvent Z(→ee) jj = 25.9, Alpgen W(→eν) bb j = 10.3, MadEvent Z(→ee) jjj = 9.2, MadEvent W(→eν) gamma = 8.1, MadEvent Z(→ee) j = 7.7, Alpgen W(→eν) bb = 6.8, Pythia jj 60 < pT < 90 = 5.8, Alpgen W(→eν) bb jj = 5.1, Pythia jj 90 < pT < 120 = 4.4, Overlaid events = 3.6, Pythia jj 40 < pT < 60 = 2.2, Pythia gamma j 80 < pT = 1.9, Pythia jj 150 < pT < 200 = 1.5, Pythia jj 120 < pT < 150 = 1.5, Pythia jj 200 < pT < 300 = 1.3, Pythia bj 60 < pT < 90 = 1.3, Pythia gamma j 45 < pT < 80 = 1.2, MadEvent Z(→ee) bb = 0.7, Pythia bj 40 < pT < 60 = 0.7, MadEvent Z(→ee) gamma = 0.6, Pythia WZ = 0.6, Pythia Z(→τ τ) = 0.5, MadEvent gamma gamma jj = 0.5, Pythia bj 90 < pT < 120 = 0.4, Pythia bj 150 < pT < 200 = 0.4, Cosmic (photon_25_iso) = 0.4, Pythia bj 18 < pT < 40 = 0.4, Pythia ZZ = 0.3, MadEvent W(→μν) gamma = 0.3, MadEvent Z(→νν) gamma = 0.2, MadEvent W(→μν) jjj = 0.2	mass(j2)/j2_pt 3.4

Example Final State

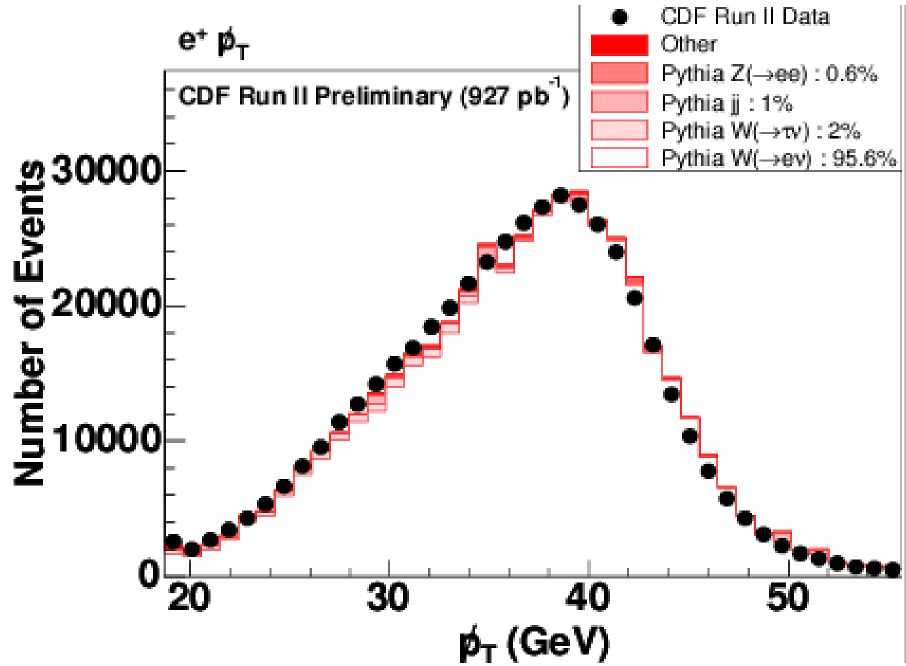
- ♦ one photon and one tau

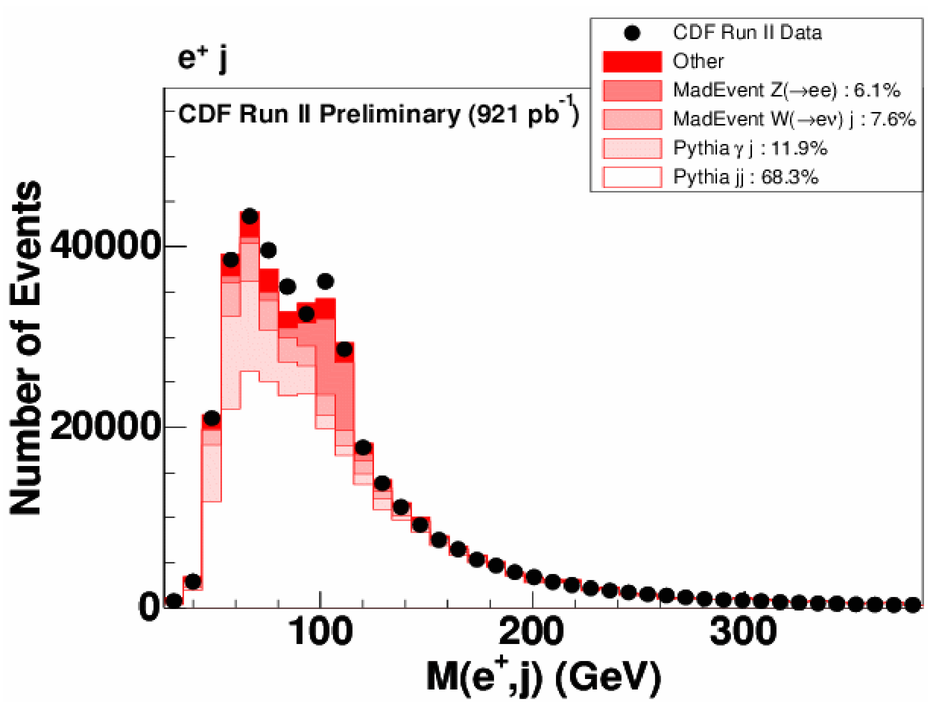
1ph1tau+	[plots]	177	204.4+-5.4	0	Pythia gammaj 45 < pT < 80 = 76.1, Pythia jj 40 < pT < 60 = 48.5, Pythia jj 60 < pT < 90 = 35.3, Pythia gammaj 22 < pT < 45 = 23.8, Pythia Z(→ee) = 10.3, Pythia jj 90 < pT < 120 = 3.3, Pythia jj 18 < pT < 40 = 1.8, Pythia gammaj 80 < pT = 1.7, Pythia Z(→τ τ) = 1.6, Pythia W(→τ ν) = 0.4, MadEvent W(→eν) j = 0.3, MadEvent Z(→ee) = 0.3, Pythia bj 40 < pT < 60 = 0.2, Pythia jj 120 < pT < 150 = 0.1, MadEvent Z(→ee) j = 0.1

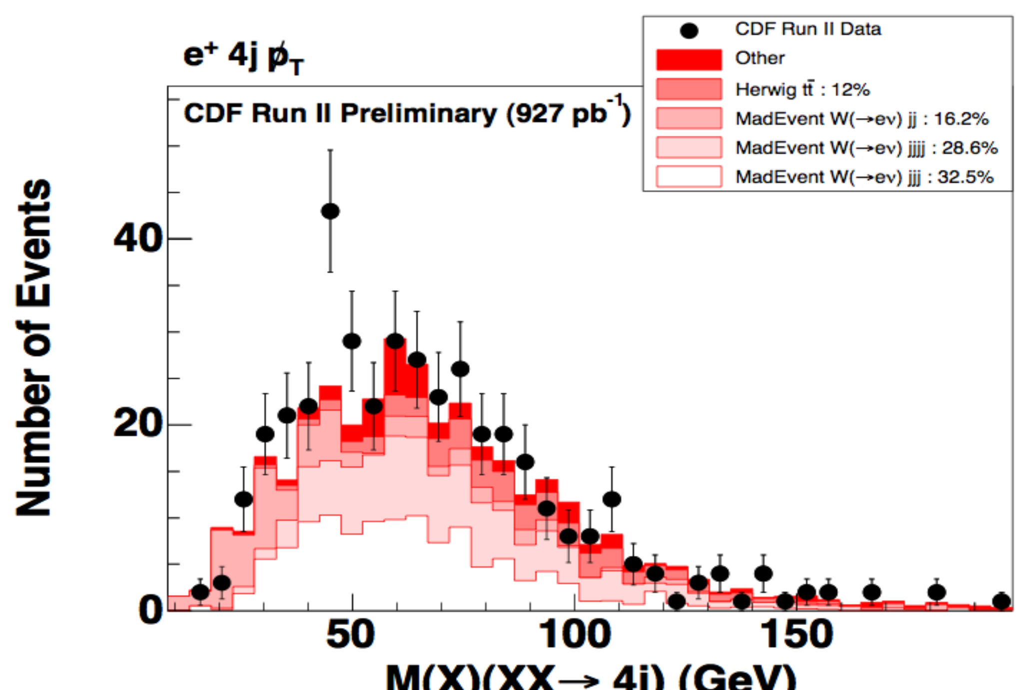


Vista Agreements

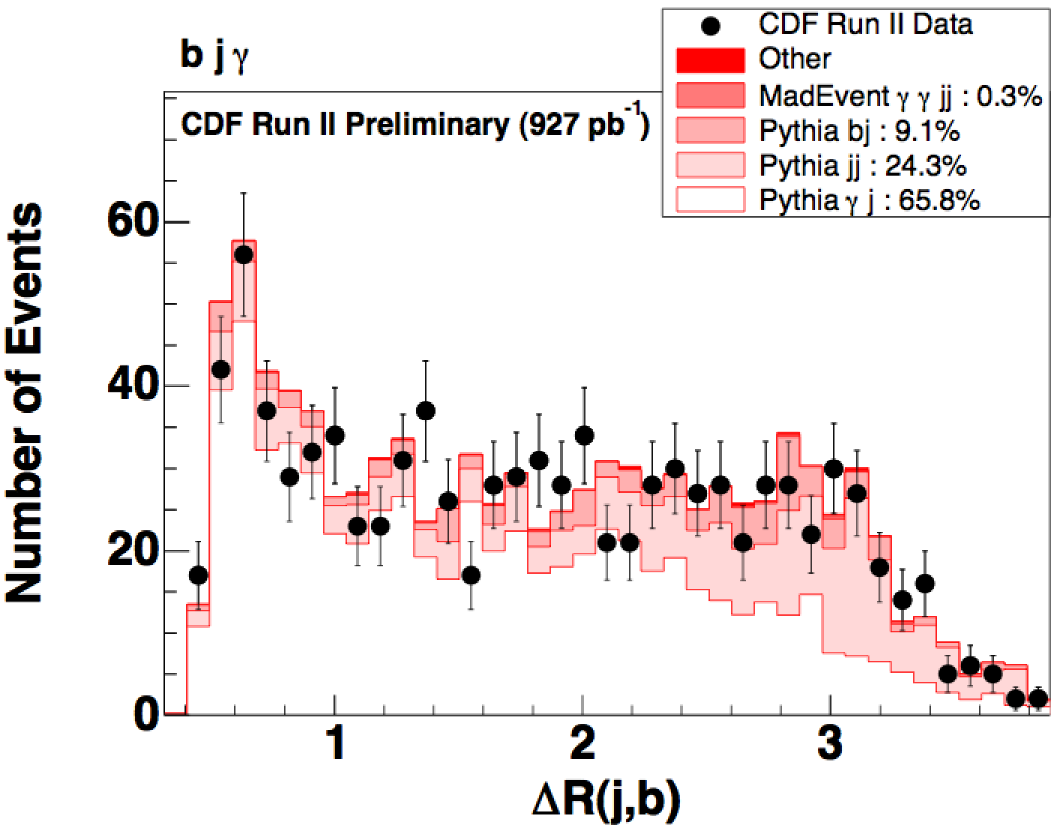
- ♦ W high S/N, stats
- ♦ e j fakes agreement
- ♦ e 4j Met top sample

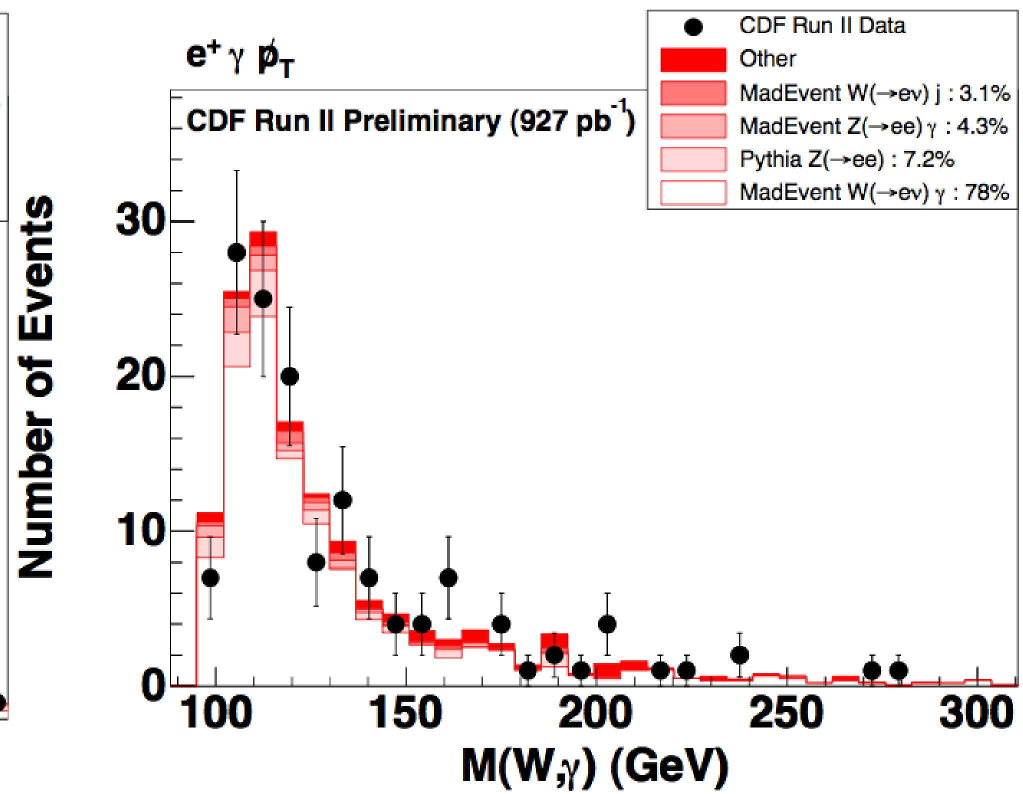






Vista Agreements





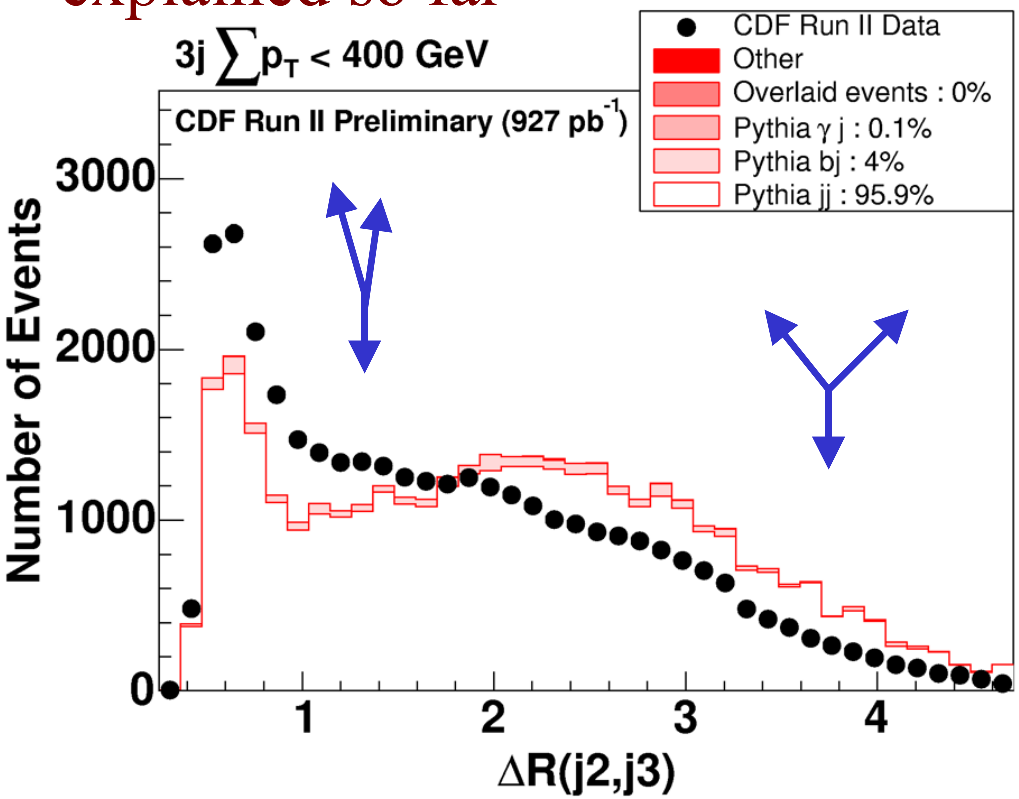
Good agreement in final states with no influence on fit

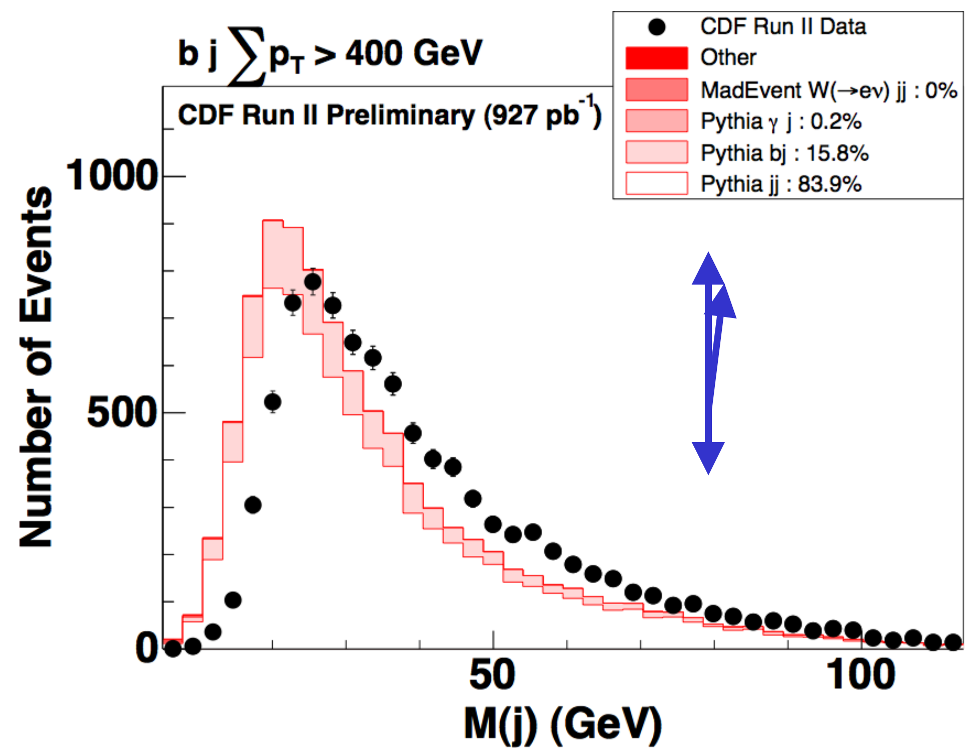
Vista Discrepancies

♦ 3j discrepancies significant, but also difficult to rule out the mundane

♦ under investigation, NLO looks better but has not been completely explained so far

♦ the same discrepancy apparently affects the jet mass distributions



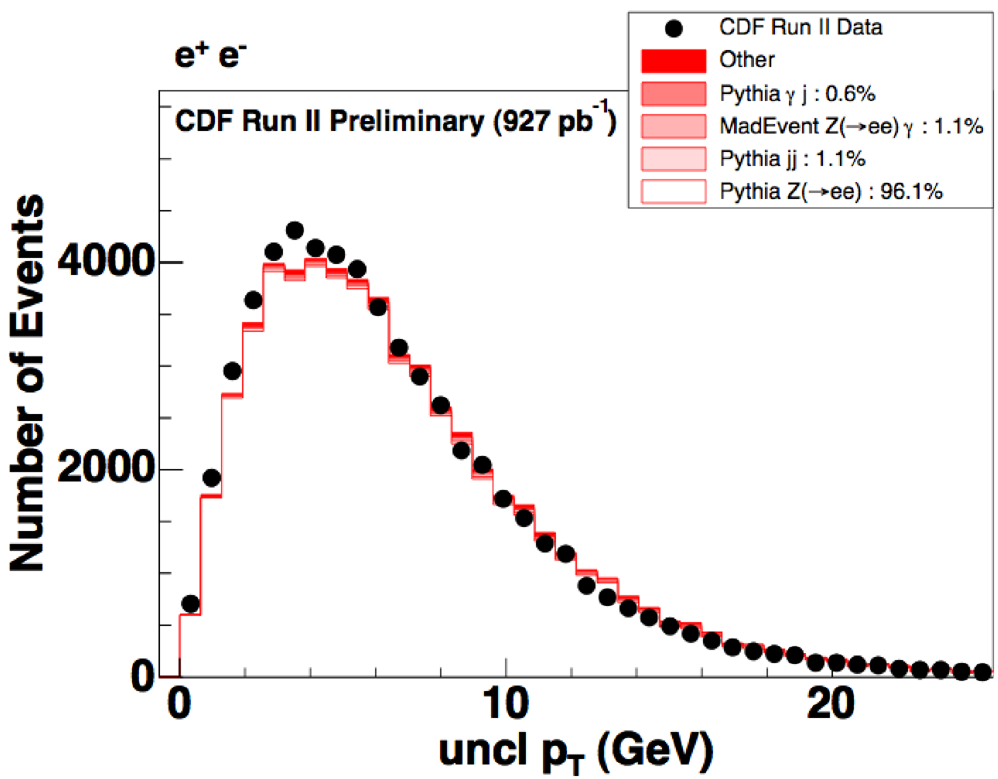


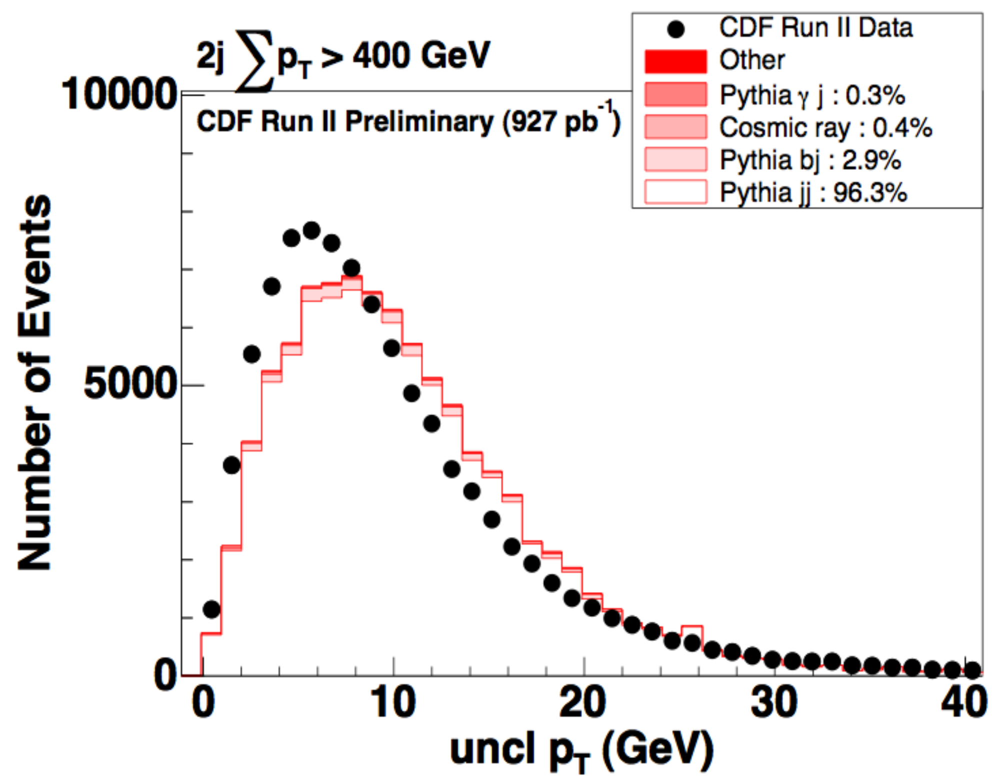
Vista Discrepancies

- ♦ intrinsic Kt is tuned on a few final states (ee, μμ, γγ..)

$$p(k_T) \propto (k_T < m/5) \times [0.8 * \text{gaussian}(\mu = 0, \sigma = 2.55\,\text{GeV} + 0.0085 \sum p_T) + 0.2 * \text{gaussian}(\mu = 0, \sigma = 5.25\,\text{GeV} + 0.0175 \sum p_T)],$$

- ♦ works well for majority
- ♦ does not work on some final states





Vista to Sleuth

- overall Vista shows excellent agreement in almost all areas
- few discrepancies, but unlikely to be due to new physics

Vista:
bulk yields,
kinematics

Sleuth:
high-Pt tails

- “optimized” quasi-model-independent search

Sleuth Overview

Assumptions

♦ the new physics appears as *excess* on the SumPt tail

- high mass, threshold production

  ♦ the new physics appears mostly in one final state

- currently no method to combine final states

Limitations

♦ optimized for models matching assumptions well

♦ not sensitive to small mass peaks like Higgs
(a bump hunter is obvious addition)

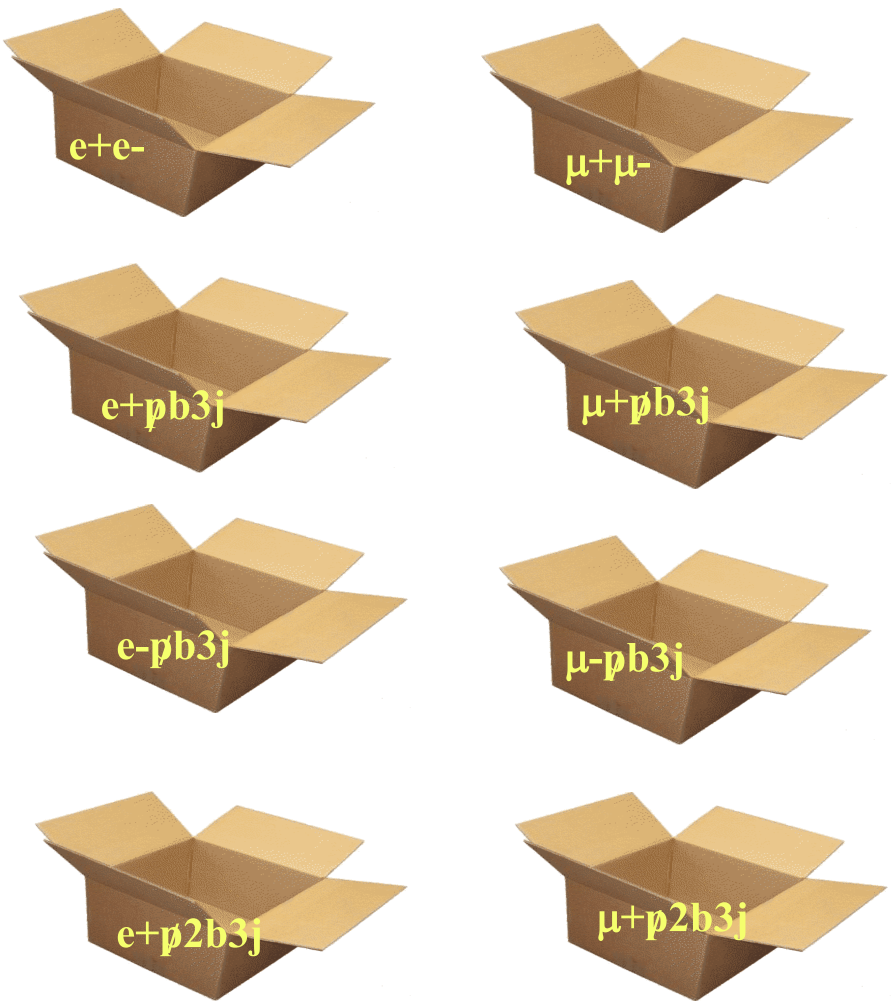
♦ less sensitive to low-pt models

Sleuth Method

1) Histogram SumPt distributions of all high-Pt final states
2) compare to SM prediction
3) find most significant region in SumPt plot for each final state
4) find overall significance, including trials factor
5) iterate to improve bg model if necessary
6) stop: evidence of/no evidence of new physics

Sleuth Partitioning

Vista



Sleuth

Lesser generation equivalence

$$e^{+} \equiv \mu^{+}$$

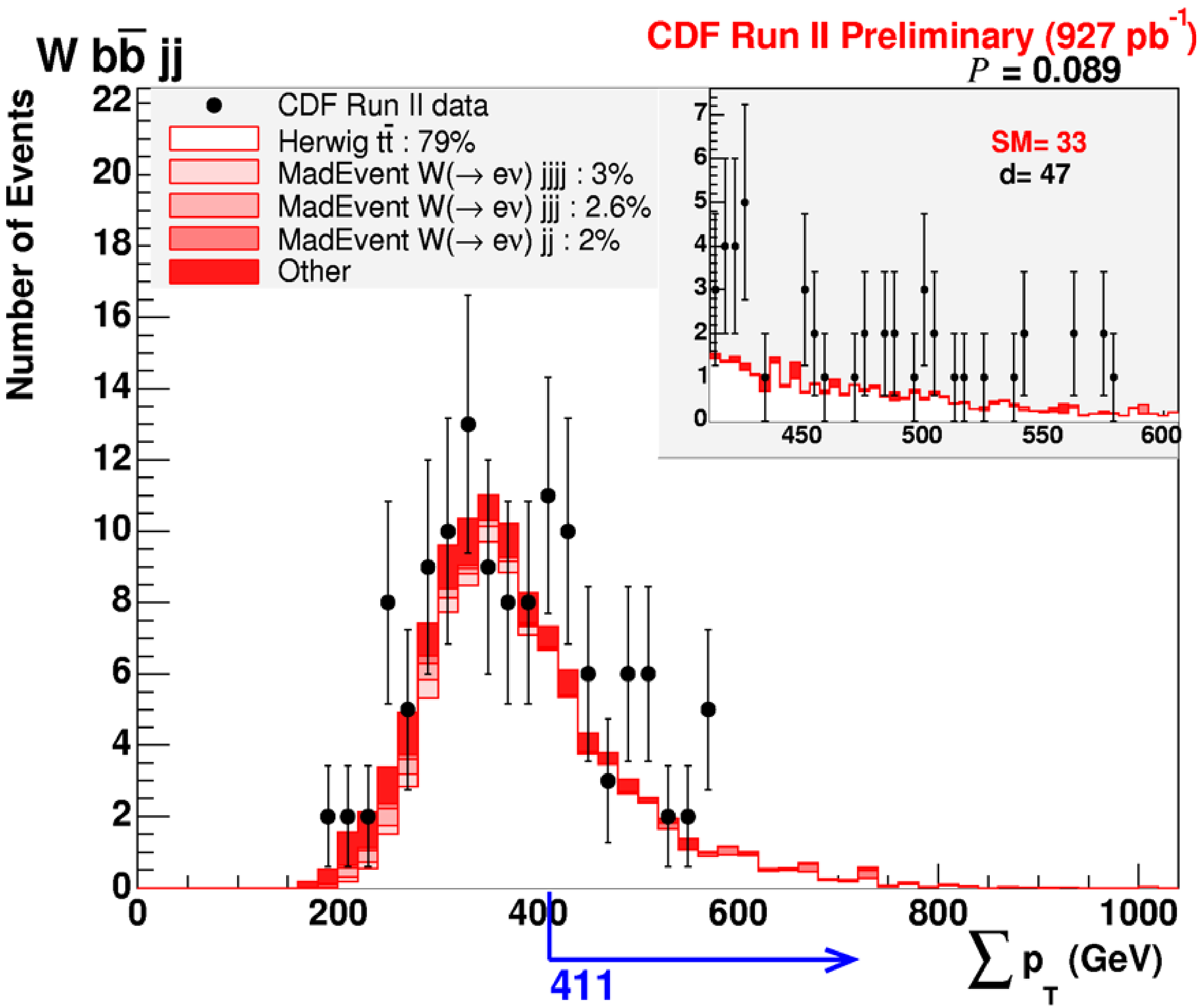
Quark jets come in pairs

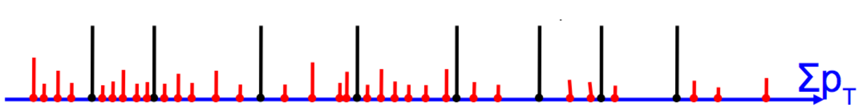
$$2j \equiv 3j$$

$$4j \equiv 5j$$

$$bj \equiv bb \equiv bjj \equiv bbj$$

Sleuth Statistic





♦ for each event, sum data and BG from data to infinity

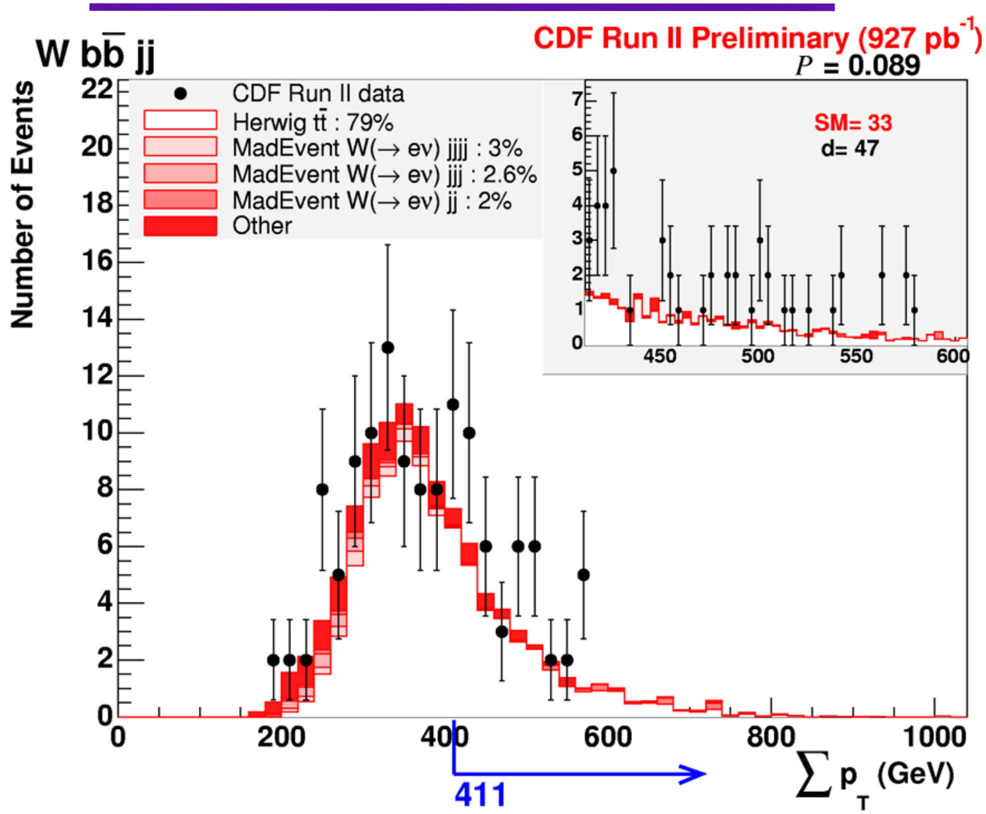
♦ generate pseudo-experiments to access significance

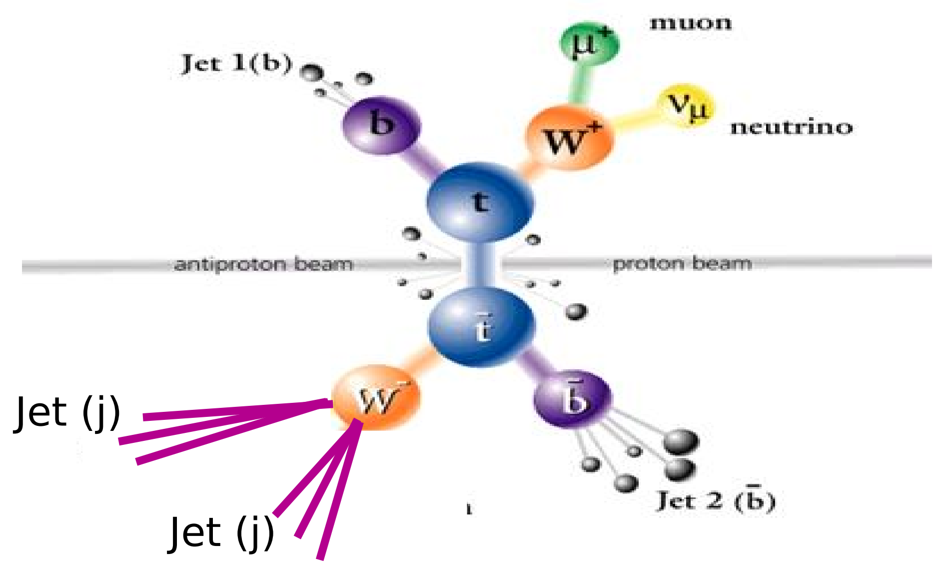
♦ this defines P

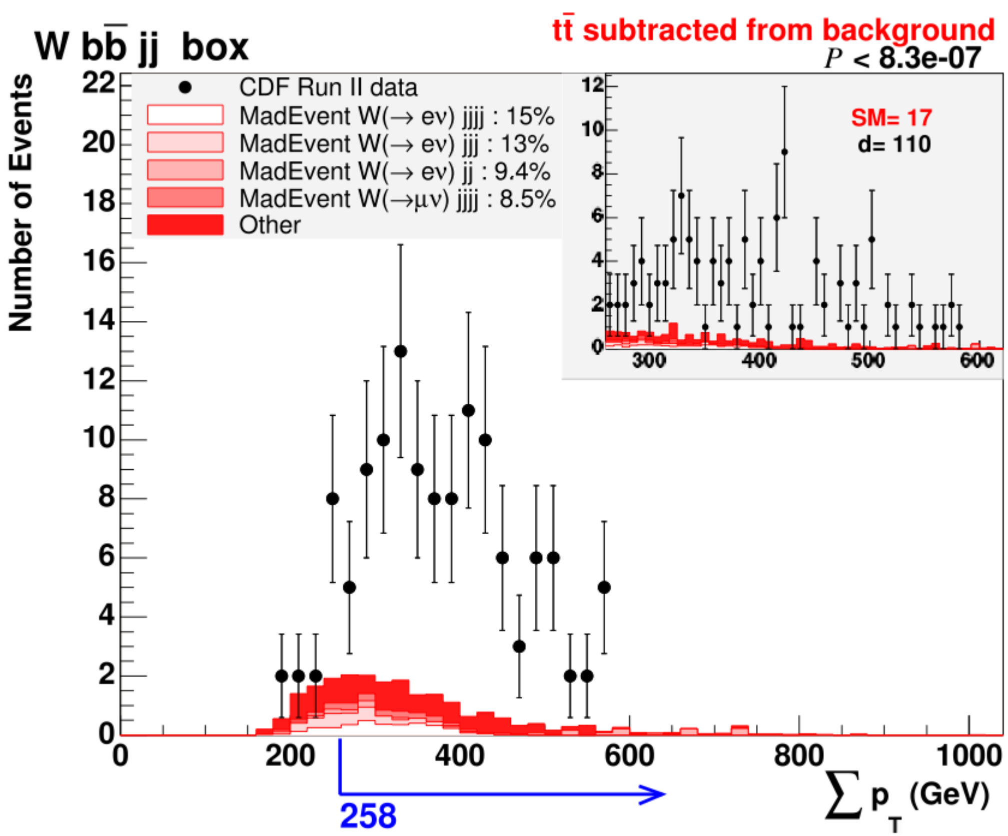
♦ find combined global significance $\tilde{P}$

♦ "discovery" criteria is $\tilde{P}$<0.001

Does this work?



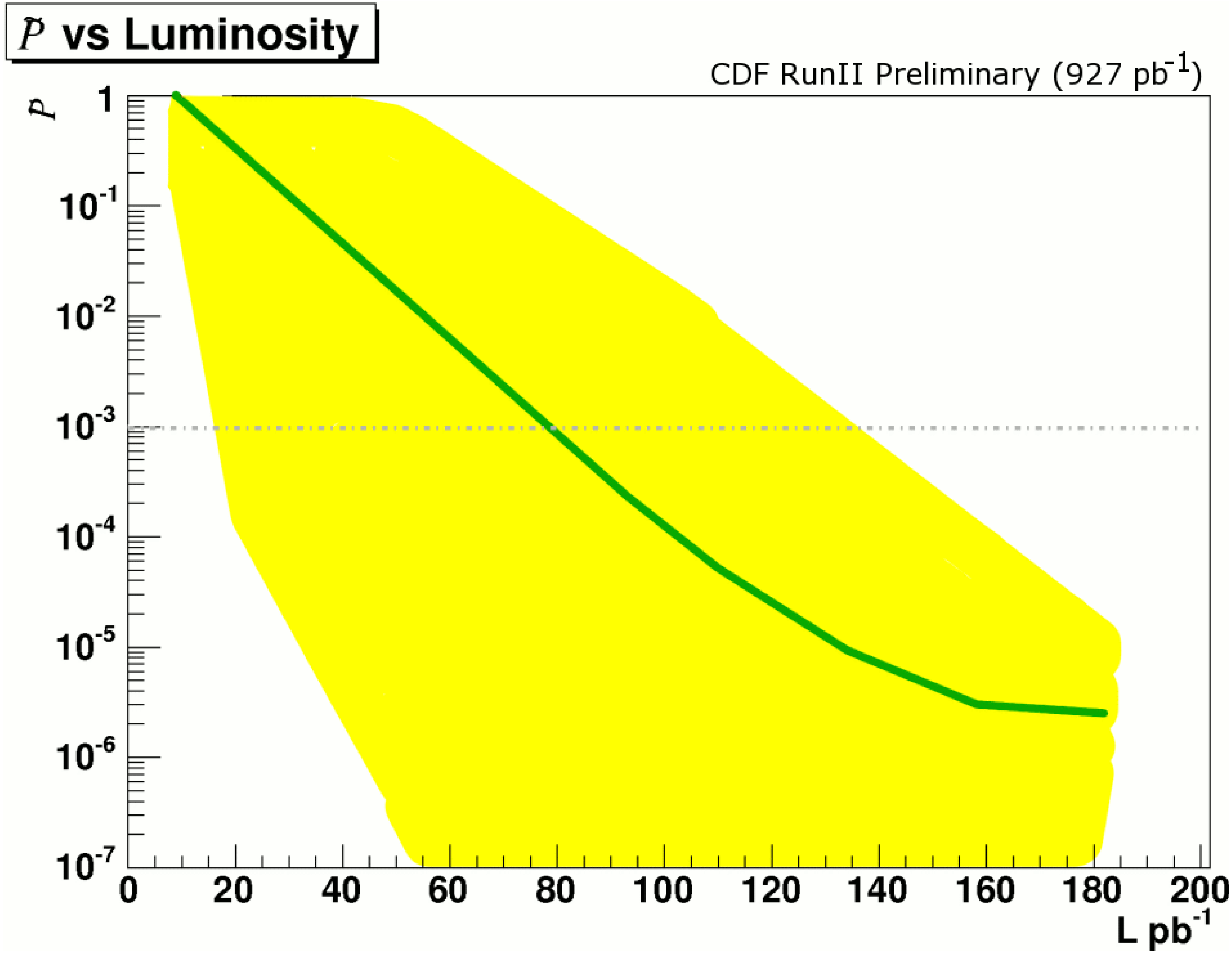




- ♦remove top, refit
- ♦sleuth would “discover” top with ~80pb^{-1}
- ♦actual discovery was about 60pb^{-1}

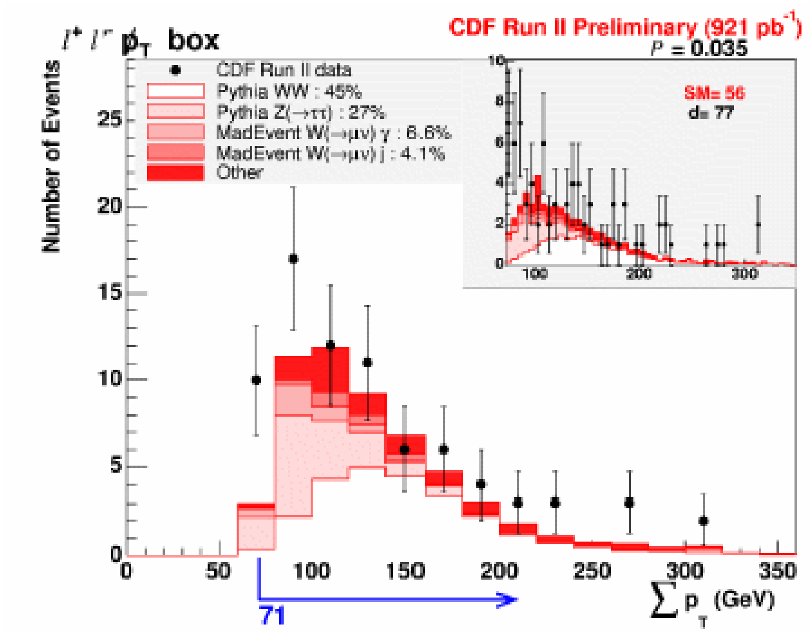
Does this work?

♦top pseudo-experiments

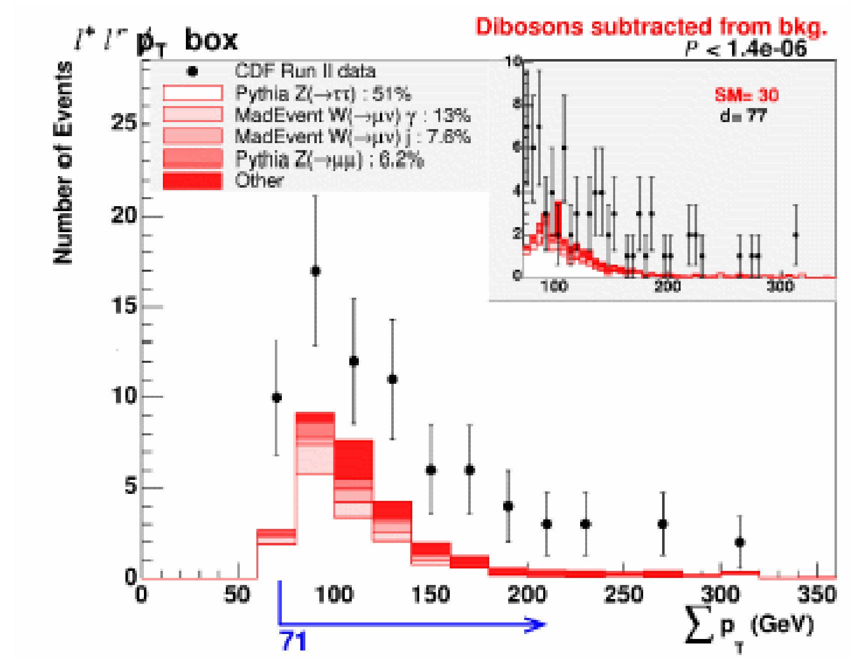


Does this work?

ll MEt normally



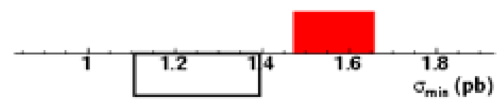
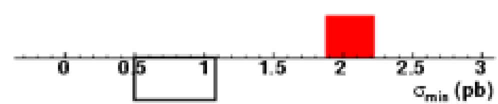
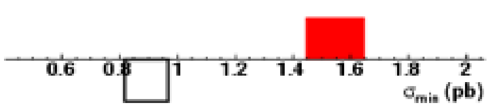
ll MEt after removing WW



- it would discover WW, even after refitting
- reasonably sensitive to high mass Higgs
- not as sensitive to light Higgs as dedicated analysis
- less sensitive to single top than dedicated analysis

Does this work?

CDF Run II Preliminary (927 pb^{-1})

Name	Description	Sensitivity
Model 01	GMSB, $\Lambda = 82.6$ GeV, $\tan\beta = 15$, $\mu > 0$, 1 messenger of $M = 2\Lambda$	
Model 02	$Z'_{(250\,\mathrm{GeV}/c^2)} \to \ell\bar{\ell}$, with $\ell \neq \nu$	
Model 03	$Z'_{(700\,\mathrm{GeV}/c^2)} \to q\bar{q}$	
Model 04	$Z'_{(1\,\mathrm{TeV}/c^2)} \to q\bar{q}$	
Model 05	mSUGRA, $M_0 = 100$ GeV, $M_{1/2} = 180$ GeV, $A_0 = 0$, $\tan\beta = 5$, $\mu > 0$	
Model 06	mSUGRA, $M_0 = 284$ GeV, $M_{1/2} = 100$ GeV, $A_0 = 0$, $\tan\beta = 5$, $\mu < 0$	
Model 07	mSUGRA, $M_0 = 300$ GeV, $M_{1/2} = 200$ GeV, $A_0 = 0$, $\tan\beta = 5$, $\mu < 0$	

Systematics

♦ standard systematic error analysis would be ~ prohibitive and is not included

♦ discrepancies are debugged and model adjusted (physically, requiring agreement with all data) reducing systematic effects

♦ typical variation of a fit parameter gives 10% variation in SM background

♦ if we find limits on generic models, varying fit parameters slowly varies limits

CDF Run II Preliminary (927 pb^{-1})

Code	Category	Explanation	Value	Error	Error(%)
5001	luminosity	CDF integrated luminosity	927.1	20	2.2
5102	k-factor	cosmic_ph	0.686	0.05	7.3
5103	k-factor	cosmic_j	0.4464	0.014	3.1
5121	k-factor	$1\gamma1j$ photon+jet(s)	0.9492	0.04	4.2
5122	k-factor	$1\gamma2j$	1.205	0.05	4.1
5123	k-factor	$1\gamma3j$	1.483	0.07	4.7
5124	k-factor	$1\gamma4j+$	1.968	0.16	8.1
5130	k-factor	$2\gamma0j$ diphoton(+jets)	1.809	0.08	4.4
5131	k-factor	$2\gamma1j$	3.417	0.24	7.0
5132	k-factor	$2\gamma2j+$	1.305	0.16	12.3
5141	k-factor	W0j W (+jets)	1.453	0.027	1.9
5142	k-factor	W1j	1.059	0.03	2.8
5143	k-factor	W2j	1.021	0.03	2.9
5144	k-factor	W3j+	0.7582	0.05	6.6
5151	k-factor	Z0j Z (+jets)	1.419	0.024	1.7
5152	k-factor	Z1j	1.177	0.04	3.4
5153	k-factor	Z2j+	1.035	0.05	4.8
5161	k-factor	2j $\hat{p}_T<150$ dijet	0.9599	0.022	2.3
5162	k-factor	2j $150<\hat{p}_T$	1.256	0.028	2.2
5164	k-factor	3j $\hat{p}_T<150$ multijet	0.9206	0.021	2.3
5165	k-factor	3j $150<\hat{p}_T$	1.36	0.032	2.4
5167	k-factor	4j $\hat{p}_T<150$	0.9893	0.025	2.5
5168	k-factor	4j $150<\hat{p}_T$	1.705	0.04	2.3
5169	k-factor	5j+ low	1.252	0.05	4.0
5211	misId	$p(e\to e)$ central	0.9864	0.006	0.6
5212	misId	$p(e\to e)$ plug	0.9334	0.009	1.0
5213	misId	$p(\mu\to\mu)$ CMUP	0.8451	0.008	0.9
5214	misId	$p(\mu\to\mu)$ CMX	0.915	0.011	1.2
5216	misId	$p(\gamma\to\gamma)$ central	0.9738	0.018	1.8
5217	misId	$p(\gamma\to\gamma)$ plug	0.9131	0.018	2.0
5219	misId	$p(b\to b)$ central	0.9969	0.04	4.0
5245	misId	$p(e\to\gamma)$ plug	0.04452	0.012	27.0
5256	misId	$p(q\to e)$ central	9.71×10^{-5}	1.9×10^{-6}	2.0
5257	misId	$p(q\to e)$ plug	0.0008761	1.8×10^{-5}	2.1
5261	misId	$p(q\to\mu)$	1.157×10^{-5}	2.7×10^{-7}	2.3
5273	misId	$p(j\to b)$ $25<p_T$	0.01684	0.00027	1.6
5285	misId	$p(q\to\tau)$ $15<p_T<60$	0.003414	0.00012	3.5
5286	misId	$p(q\to\tau)$ $60<p_T<200$	0.000381	4×10^{-5}	10.5
5292	misId	$p(q\to\gamma)$ central	0.0002651	1.5×10^{-5}	5.7
5293	misId	$p(q\to\gamma)$ plug	0.001591	0.00013	8.2
5401	trigger	$p(e\to$trig) central, $p_T>25$	0.9758	0.007	0.7
5402	trigger	$p(e\to$trig) plug, $p_T>25$	0.835	0.015	1.8
5403	trigger	$p(\mu\to$trig) CMUP, $p_T>25$	0.9166	0.007	0.8
5404	trigger	$p(\mu\to$trig) CMX, $p_T>25$	0.9613	0.01	1.0

including systematics only makes a null result more null

Sleuth Result

And the answer is ... $\tilde{\mathcal{P}} = 0.46$

the probability that the most discrepant final state would be more discrepant is 0.46 = no significant excess

this does not prove no new physics

This global search reveals no significant indication of new physics

There exists a simple, well-motivated implementation of the standard model, consistent with the entire high-Pt dataset, that also explains the SumPt tails of all final states

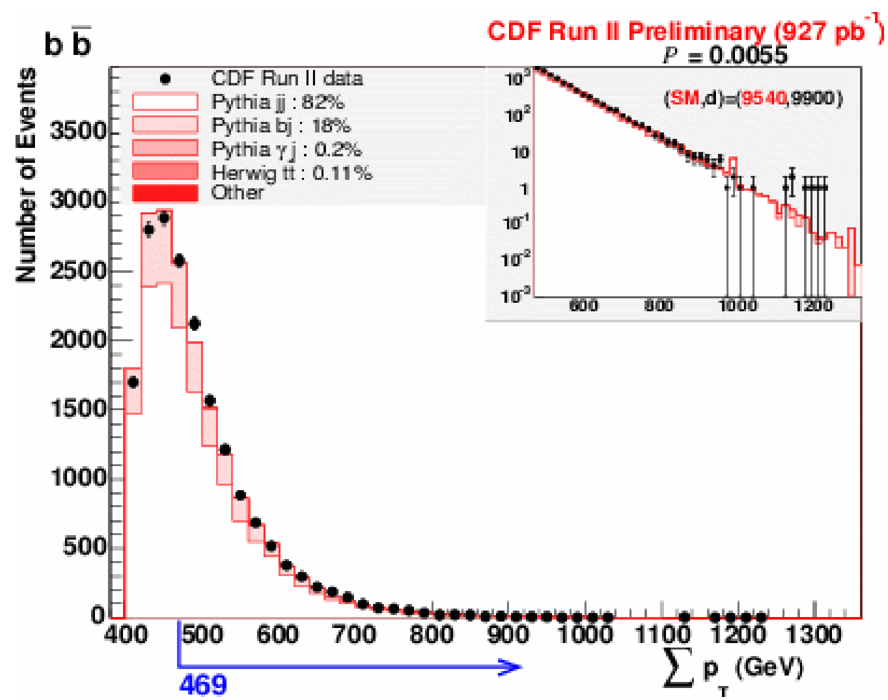
Sleuth Most Discrepant

the most discrepant final states:

Sleuth Final State	$\mathcal{P}$
$b\bar{b}$	0.0055
$j\,\not{p}$	0.0092
$\ell^+\ell'^+\,\not{p}jj$	0.011
$\ell^+\ell'^+\,\not{p}$	0.016
$\tau\,\not{p}$	0.016

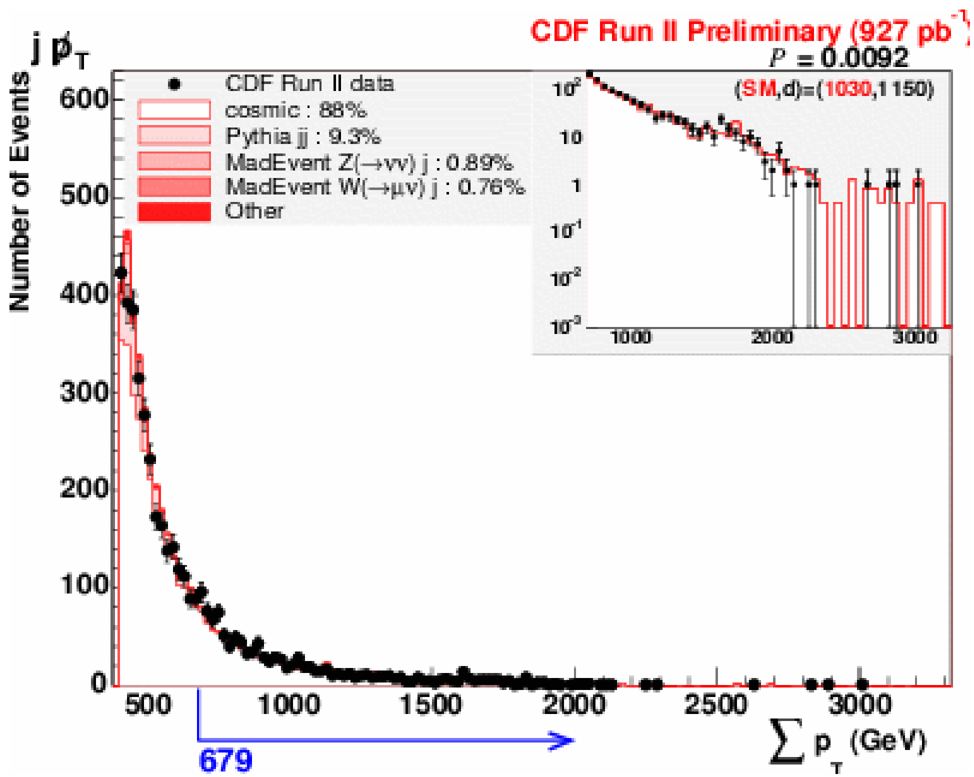
♦ Do not reveal hints of new physics

♦ are not statistically significant after considering trials factors

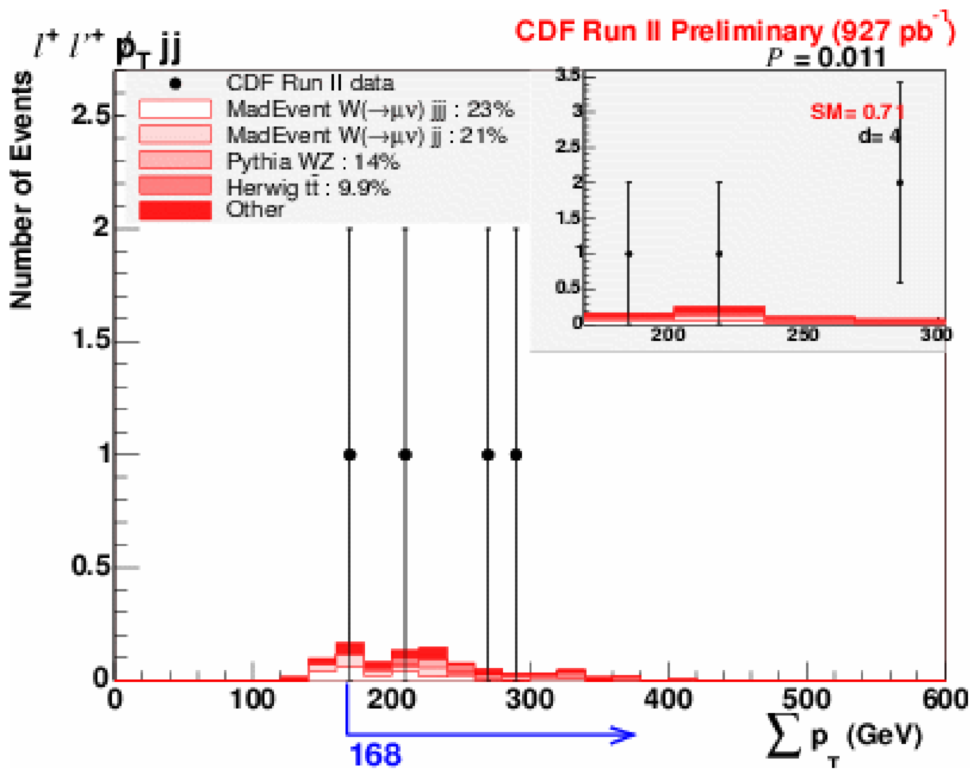


Sleuth Most Discrepant

j Met dominated by cosmics



like-sign leptons dominated by fakes



DF Vista/Sleuth Result

Vista

- scans 16K kinematic distributions
- debugging background estimate
- defines a 44 parameter correction model
- finds no discrepancies indicating new physics

Sleuth

- applies background model
- searches high-SumPt tails
- is sensitive to many new physics models
- agreement in 72 final states - 0.46 probability

The search continues

- dedicated searches, and Sleuth continue
- Sleuth 2fb result is nearing completion
- a discovery could pop up with any increment
- similar search is underway at DØ
- value to LHC experiments...

The single most encompassing test of the Standard Model on the energy frontier to date

The Logical Continuation

Bard

- ♦ Given an excess, what particles could have particpated
- ♦ search all quantum numbers, vertices using MADGRAPH

B. Knuteson, S. Mrenna, e-Print: hep-ph/0602101

Marmoset

- ♦ build an "on-shell effective theory" for a set of excesses
- ♦ simulate the consequences, work towards final theory

N. Arkani-Hamed, P. Schuster, N. Toro, J. Thaler, L. Wang, B. Knuteson, S. Mrenna, e-Print: hep-ph/0703088

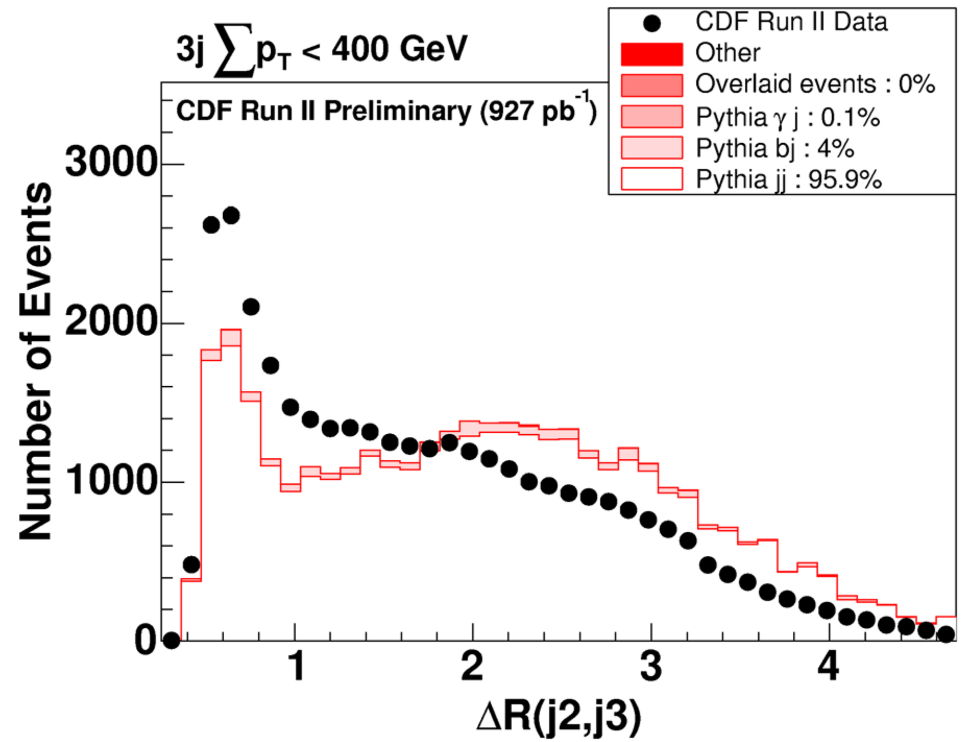
Quaero

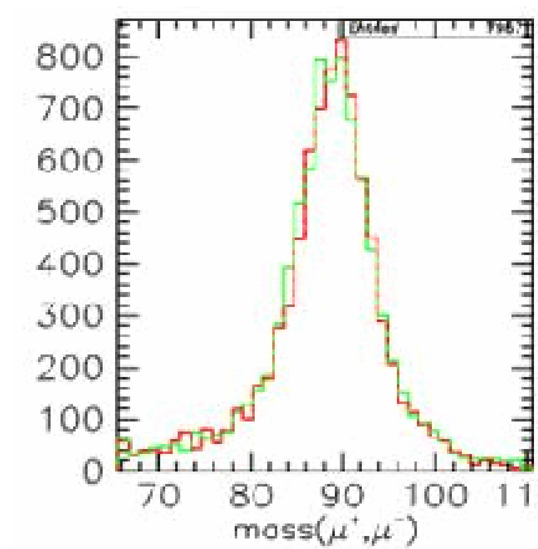
- ♦ test a model against a dataset
- ♦ Can be run by anyone
- ♦ DØ Run I http://mit.fnal.gov/Quaero

TurboSim

Working on this discrepancy
- Likely a showering problem
- little MC tuning since 90's
    much expected for LHC era
- need to test tunes, but
  simulation time per event
  is a very real problem

Turbocharge it!
- Examine ~10M of full sim events
- save parton → recon
for each particle type, for Pt, η, ϕ
- allow look-up of N → M
- result is ~1% precision, plenty
for most studies, and fast - 10ms!
- plenty of other uses...





Vista/Sleuth Family Tree

D0 Run I

- Phys Rev D 62, 092004, 2000
- Phys Rev D 62, 012004, 2001
- Phys Rev Lett 86, 3712, 2001
- Phys Rev Lett 87, 231801, 2001

Vista@L3

- Performed

Vista@Aleph

- Performed

Sleuth, Quaero@H1

- Phys. Lett. B 602: 14-30, 2004
- Eur. Phys. J. C53:167,2008

CDF Run II

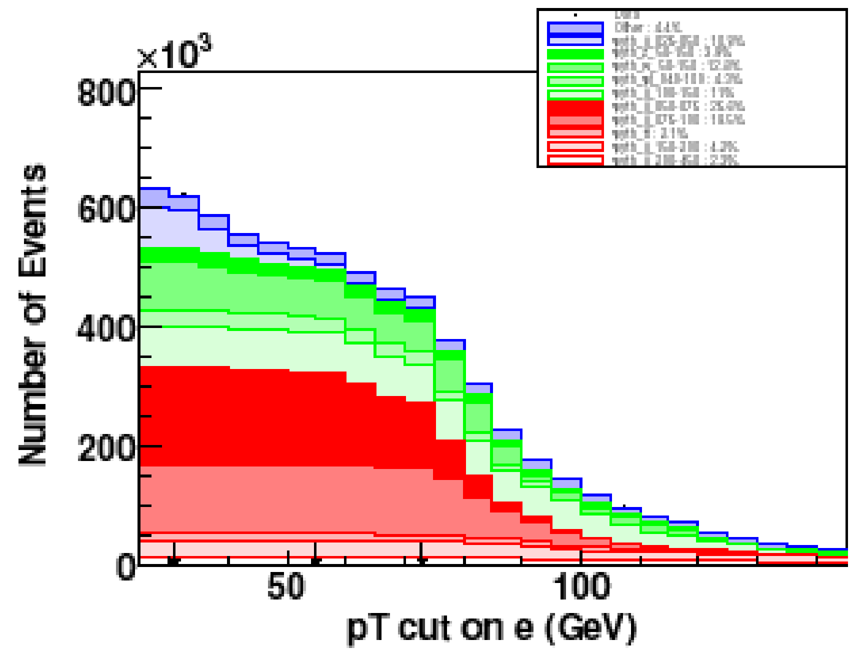
- Just blessed → PRL, PRD

D0 Run II

- Vista/Sleuth underway

The LHC Generation

- designing offline triggers



Vista/Sleuth @ LHC

Search tool

- LHC unknowns demand a tool to scan final states
- don't commit to a final state early on
- find the anomalies and attack them

Commissioning tool

- So far, Sleuth has only been an endgame, a final tuning of background and data comparison
- early on all discrepancies will be problems
  - presented in a organized way, ordered
  - complete set - wonder about a plot? we got it.
  - see where the background is coming from
- high-level - compliments low-level work

Vista shows where the real physics problems are

- flows from commissioning into searching

The search continues…

MisID matrix

CDF Run II Preliminary (927 pb^{-1})

$\|\eta\|$	0 − 0.6					0.6 − 1.0					> 1.0		
p_T	15 − 25	25 − 40	40 − 60	60 − 200	> 200	15 − 25	25 − 40	40 − 60	60 − 200	> 200	15 − 25	25 − 40	> 40
e→e	5211	5211	5211	5211	5211	5211	5211	5211	5211	5211	5212	5212	5212
e→μ	0	0	0	0	0	0	0	0	0	0	0	0	0
e→τ	0	0	0	0	0	0	0	0	0	0	0	0	0
e→γ	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	5245	5245	5245
e→j	0	0	0	0	0	0	0	0	0	0	0	0	0
e→b	0	0	0	0	0	0	0	0	0	0	0	0	0
μ→e	0	0	0	0	0	0	0	0	0	0	0	0	0
μ→μ	5213	5213	5213	5213	5213	5214	5214	5214	5214	5214	5214	5214	5214
μ→τ	0	0	0	0	0	0	0	0	0	0	0	0	0
μ→γ	0	0	0	0	0	0	0	0	0	0	0	0	0
μ→j	0	0	0	0	0	0	0	0	0	0	0	0	0
μ→b	0	0	0	0	0	0	0	0	0	0	0	0	0
τ→e	0	0	0	0	0	0	0	0	0	0	0	0	0
τ→μ	0	0	0	0	0	0	0	0	0	0	0	0	0
τ→τ	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0	0	0
τ→γ	0	0	0	0	0	0	0	0	0	0	0	0	0
τ→j	0	0	0	0	0	0	0	0	0	0	1	1	1
τ→b	0	0	0	0	0	0	0	0	0	0	0	0	0
γ→e	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.005	0.005	0.005
γ→μ	0	0	0	0	0	0	0	0	0	0	0	0	0
γ→τ	0	0	0	0	0	0	0	0	0	0	0	0	0
γ→γ	5216	5216	5216	5216	5216	5216	5216	5216	5216	5216	5217	5217	5217
γ→j	0	0	0	0	0	0	0	0	0	0	0	0	0
γ→b	0	0	0	0	0	0	0	0	0	0	0	0	0
j→e	5256	5256	5256	5256	5256	5256	5256	5256	5256	5256	5257	5257	5257
j→μ	1.5×10^{-5}	5261	5261	5261	5261	1.5×10^{-5}	5261	5261	5261	5261	0	0	0
j→τ	5285	5285	5285	5286	0.00015	5285	5285	5285	5286	0.00015	0	0	0
j→γ	5292	5292	5292	5292	5292	5292	5292	5292	5292	5292	5293	5293	5293
j→j	1	1	1	1	1	1	1	1	1	1	1	1	1
j→b	0	5273	5273	5273	5273	0	5273	5273	5273	5273	0	0	0
b→e	0	0	0	0	0	0	0	0	0	0	0	0	0
b→μ	0	0	0	0	0	0	0	0	0	0	0	0	0
b→τ	0	0	0	0	0	0	0	0	0	0	0	0	0
b→γ	0	0	0	0	0	0	0	0	0	0	0	0	0
b→j	0	0	0	0	0	0	0	0	0	0	1	1	1
b→b	5219	5219	5219	5219	5219	5219	5219	5219	5219	5219	0	0	0

MisID matrix Values

CDF Run II Preliminary (927 pb^{-1})

$\lvert\eta\rvert$	0 – 0.6					0.6 – 1.0					> 1.0		
p_T	15 – 25	25 – 40	40 – 60	60 – 200	> 200	15 – 25	25 – 40	40 – 60	60 – 200	> 200	15 – 25	25 – 40	> 40
$e \to e$	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.93	0.93	0.93
$e \to \mu$	0	0	0	0	0	0	0	0	0	0	0	0	0
$e \to \tau$	0	0	0	0	0	0	0	0	0	0	0	0	0
$e \to \gamma$	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	4×10^{-3}	0.045	0.045	0.045
$e \to j$	0	0	0	0	0	0	0	0	0	0	0	0	0
$e \to b$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\mu \to e$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\mu \to \mu$	0.85	0.85	0.85	0.85	0.85	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
$\mu \to \tau$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\mu \to \gamma$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\mu \to j$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\mu \to b$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\tau \to e$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\tau \to \mu$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\tau \to \tau$	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0	0	0
$\tau \to \gamma$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\tau \to j$	0	0	0	0	0	0	0	0	0	0	1	1	1
$\tau \to b$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\gamma \to e$	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.005	0.005	0.005
$\gamma \to \mu$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\gamma \to \tau$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\gamma \to \gamma$	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.91	0.91	0.91
$\gamma \to j$	0	0	0	0	0	0	0	0	0	0	0	0	0
$\gamma \to b$	0	0	0	0	0	0	0	0	0	0	0	0	0
$j \to e$	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	9.7×10^{-5}	0.00088	0.00088	0.00088
$j \to \mu$	1.5×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	1.5×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	0	0	0
$j \to \tau$	0.0034	0.0034	0.0034	0.00038	0.00015	0.0034	0.0034	0.0034	0.00038	0.00015	0	0	0
$j \to \gamma$	0.00027	0.00027	0.00027	0.00027	0.00027	0.00027	0.00027	0.00027	0.00027	0.00027	0.0016	0.0016	0.0016
$j \to j$	1	1	1	1	1	1	1	1	1	1	1	1	1
$j \to b$	0	0.017	0.017	0.017	0.017	0	0.017	0.017	0.017	0.017	0	0	0
$b \to e$	0	0	0	0	0	0	0	0	0	0	0	0	0
$b \to \mu$	0	0	0	0	0	0	0	0	0	0	0	0	0
$b \to \tau$	0	0	0	0	0	0	0	0	0	0	0	0	0
$b \to \gamma$	0	0	0	0	0	0	0	0	0	0	0	0	0
$b \to j$	0	0	0	0	0	0	0	0	0	0	1	1	1
$b \to b$	1	1	1	1	1	1	1	1	1	1	0	0	0