Model Independent Search for New Physics in Leptonic Final States at DØ

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Model Independent Search

Many Models for beyond **S**tandard **M**odel

Even mSUGRA: 5 parameters

Focused search? one model at a time

P(truth) << 1, even with a few parameters

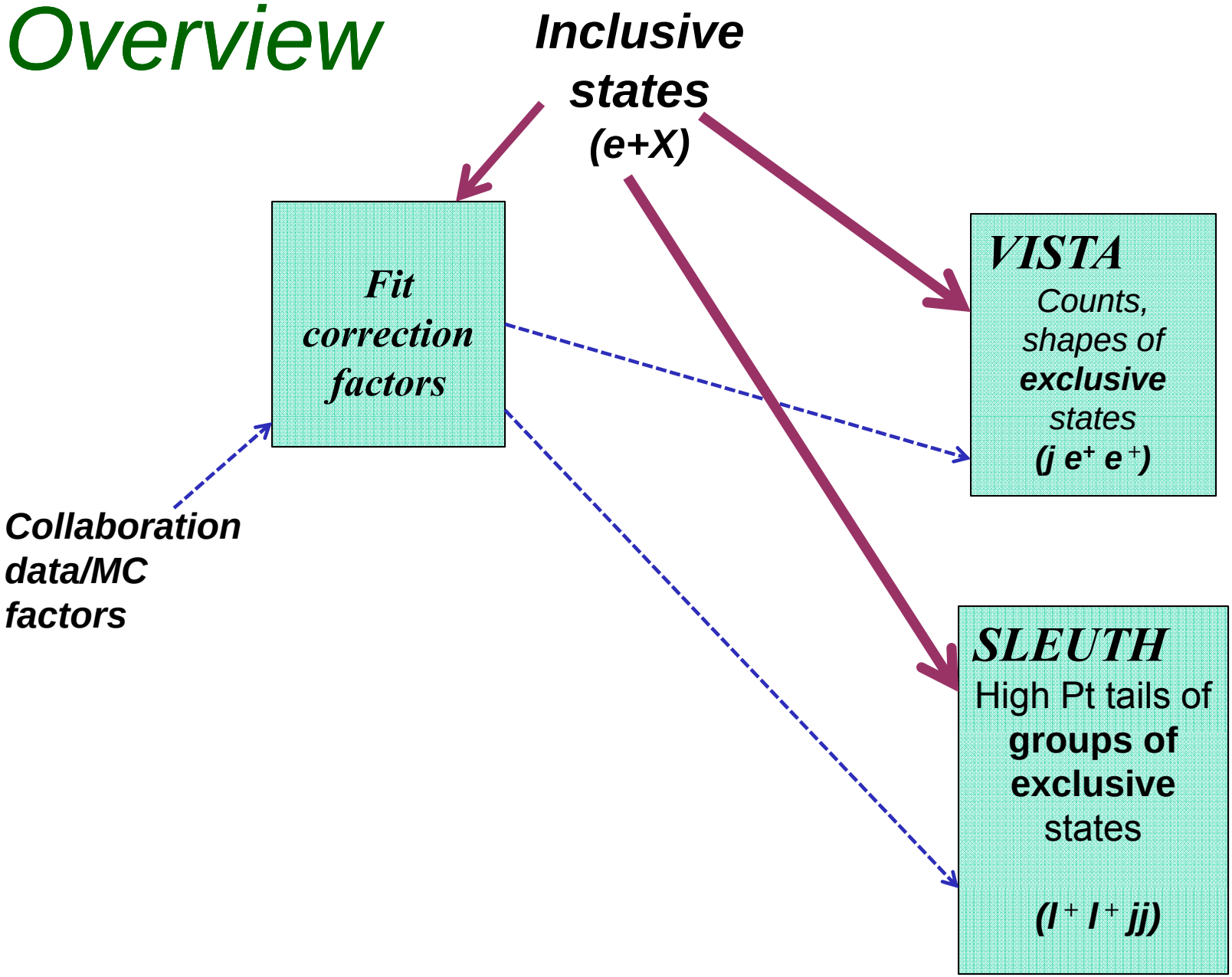
Model Independent Search:

Data different from SM?

Clearer question!

First discover , *then* try models

Overview


Inclusive states (e+X)
Fit correction factors
Collaboration data/MC factors
VISTA
Counts, shapes of exclusive states
(j e+ e+)
SLEUTH
High Pt tails of groups of exclusive states
(l+ l+ jj)

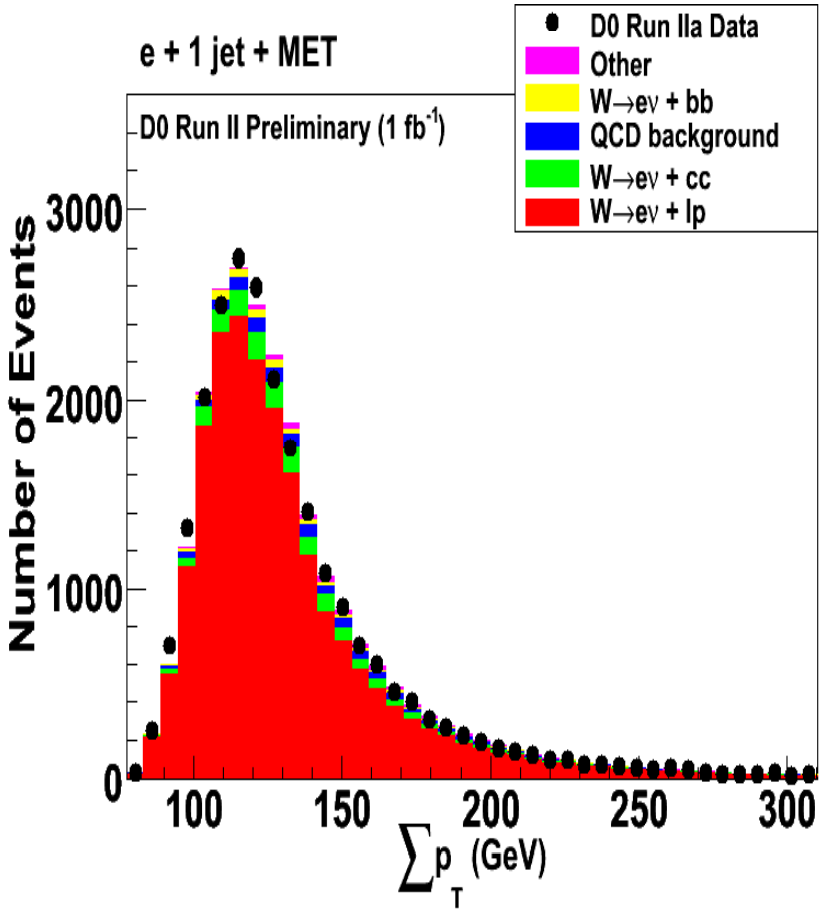
A global search has complicated results

Searches:

- Event counts in final states (Vista)
- Shape of many distributions (Vista)
- Event Σp_T distributions (Sleuth)

What if see unexpected?

- MC simulation accurate here?
- Detector modelling?
- Event reconstruction?
- New physics?



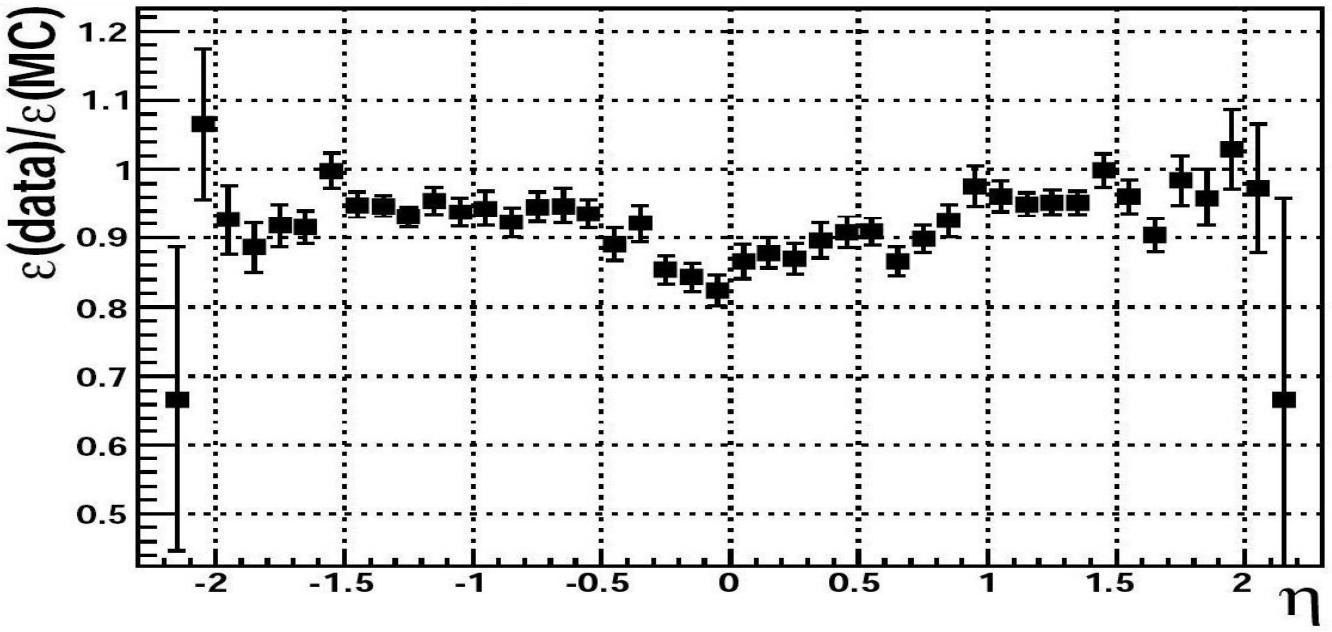
Leptonic channels vs. SM

PYTHIA and ALPGEN MC

Multijet background from data

Apply common collaboration-wide scale factors

bin-by-bin or function



μ Tracking Efficiency from $Z \rightarrow \mu\mu$

*Fit MC to Data in **Inclusive** Final States*

Fit constant normalization factors

Trigger efficiency, k-factors, etc

Fit where data dominated by SM

Exclude high-p_T tails

K-S test of data/MC shape agreement

$p_T(\ell)$, $p_T(j)$, η, ϕ, $\Delta\phi(\ell, \text{MET})$, MET histograms are fit

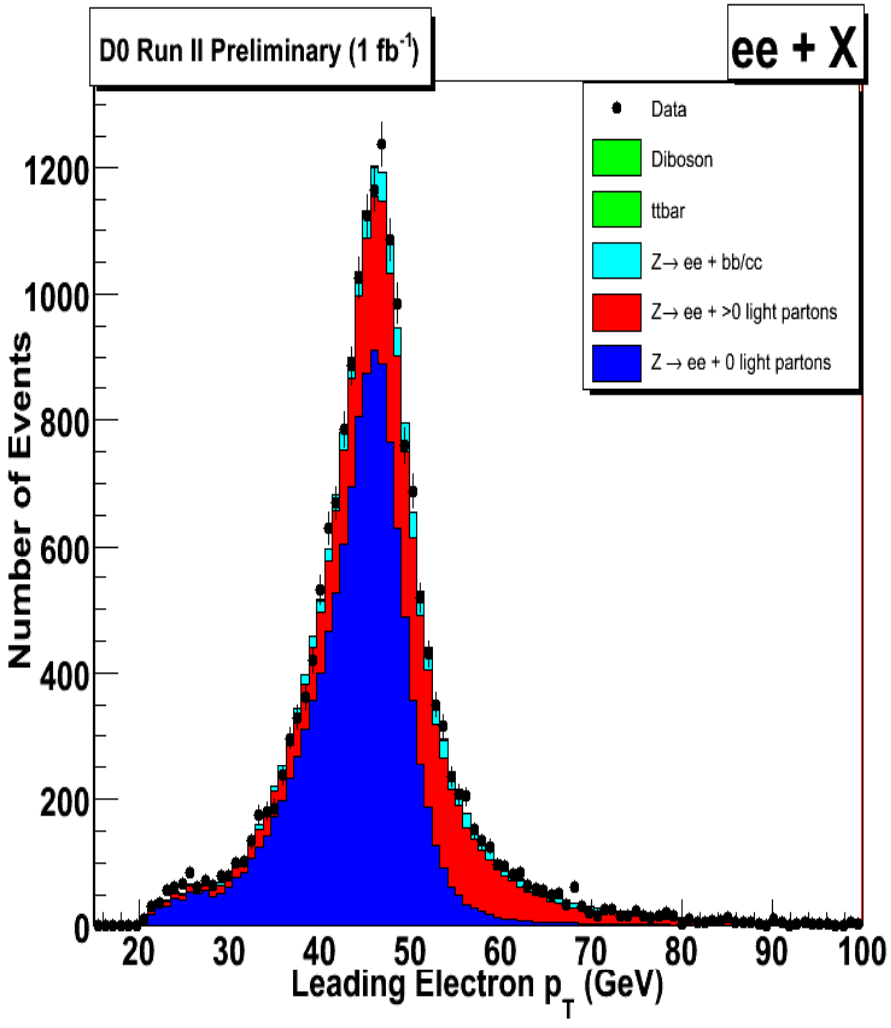
M, MT, ZpT, N(j) to check fit

This step

(standard collaboration factors,

fit correction in inclusive states)

used in DØ, not CDF



Fit MC to data in 7 inclusive final states

MIS Final State	Object	Min p_T (GeV)	Max $\|\eta\|$
e + jets + X	e	35	1.1
	jet	20	2.5
	MET	20	NA
μ + jets + X	μ	25	1.7
	jet	20	2.5
	MET	20	NA
ee + X	e	15	1.1
$\mu\mu$ + X	μ	15	2.0
$\mu\tau$ + X	μ	15	2.0
	τ	15	2.5
eτ + X	e	15	2.5
	τ	15	2.5
μe + X	μ	15	2.0
	e	15	2.5

Additional objects X

Object	Min p_T (GeV)	Max $\|\eta\|$
e	15	2.5
μ	15	2.0
τ	15	2.5
jet	20	2.5
γ	15	1.1

Require $p_T(\mu)<300$
(track resolution)

D0 Run II Preliminary

Vista *checks # events and shapes in exclusive channels*

Compare data/MC for each ***exclusive*** final state

Check number of events

Scale factors frozen, not re-fit

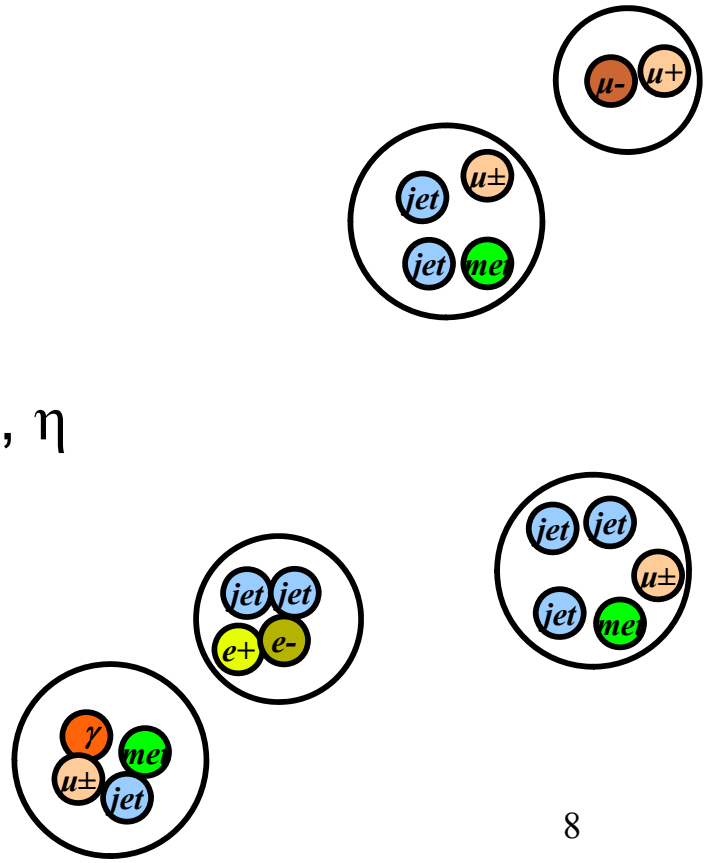
Compare shape

e.g. p_T, M(combinations), M_T, ΔR, $\Delta\phi$, η

Kolmogorov-Smirnov probability

Report significant discrepancies

> 3σ after trials factor



Vista Results: lepton + X

1 fb^{-1}

>97%agree **focus on disagreement**

Trials factor

For N final states, $P_{corr} = N * P_{nom} \Rightarrow \int^{\infty}_{\sigma} Gaus(0,1) = N \int^{\infty}_{\sigma_{nom}} Gaus(0,1)$

4/180 number and 24/9335 shape discrepancies

3 basic modelling issues

η -dependent trigger efficiency

μ+ jets + MET

Muon resolution

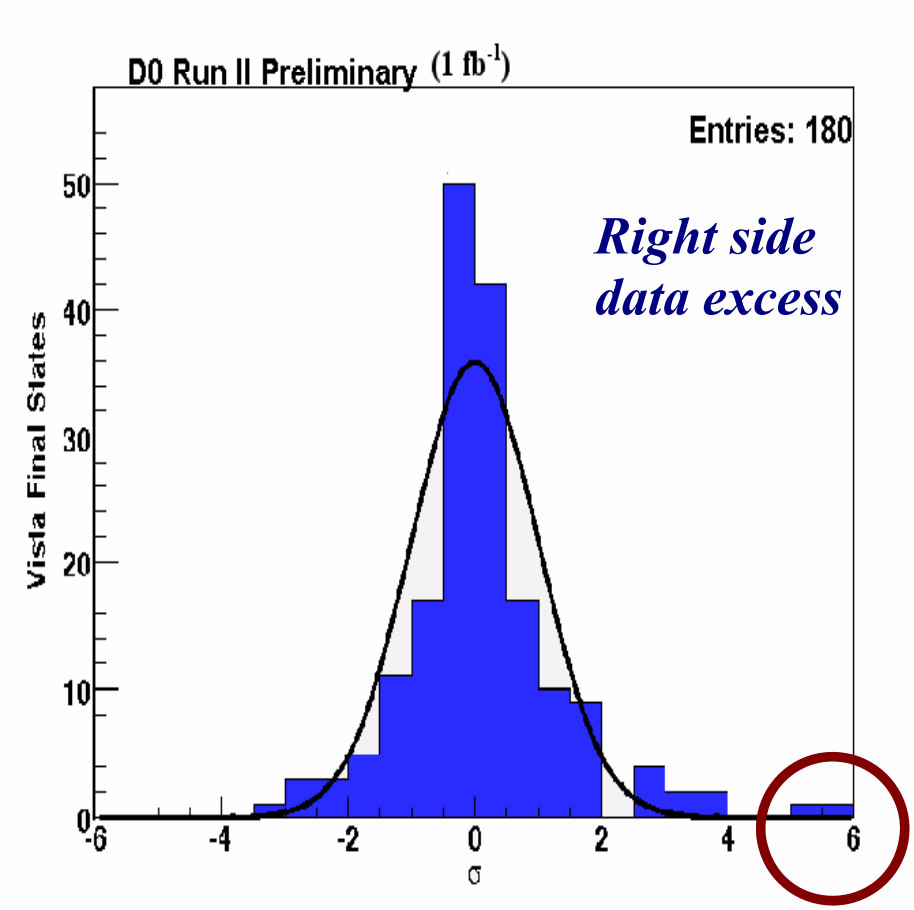
μ μ+ MET

Misidentified Jets

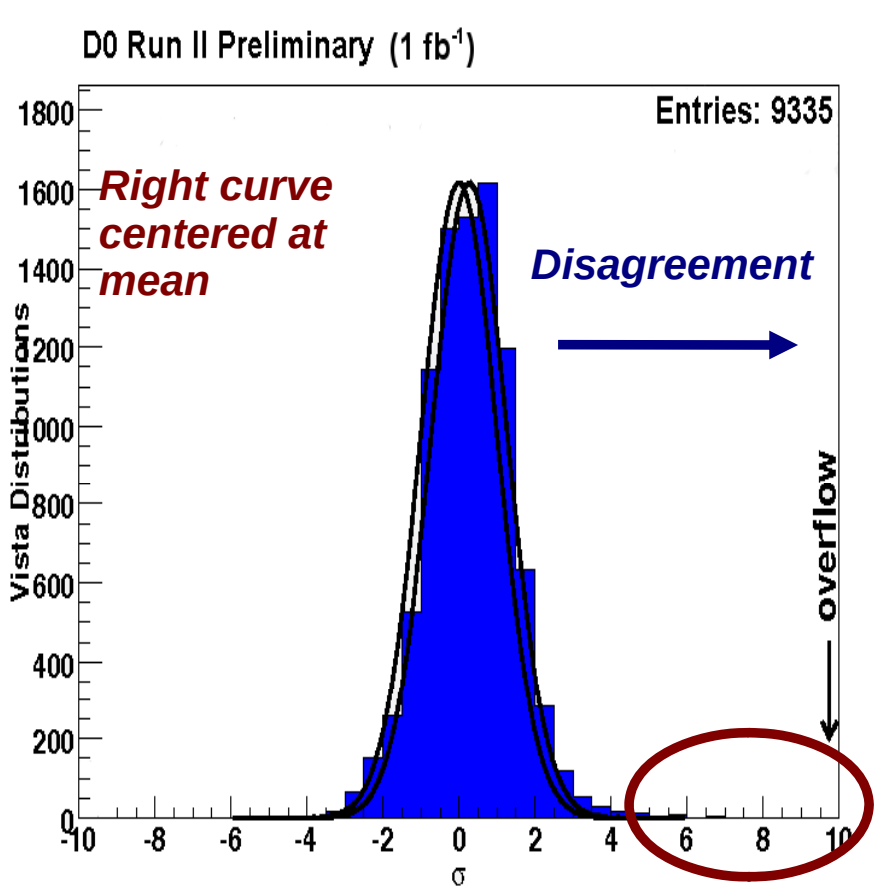
γ + X

DØ Final State Population Discrepancies	σ After Trials Factor
$\mu + 2$ jets $+ \not\!\!E_T$	9.3
$\mu + \gamma + 1$ jet $+ \not\!\!E_T$	6.6
$\mu^{\pm}\mu^{\mp} + \not\!\!E_T$	4.4
$\mu^{\pm}\mu^{\mp} + \gamma$	4.1

Data/MC Agreement (pre-trials)



4 number discrepancies after trials



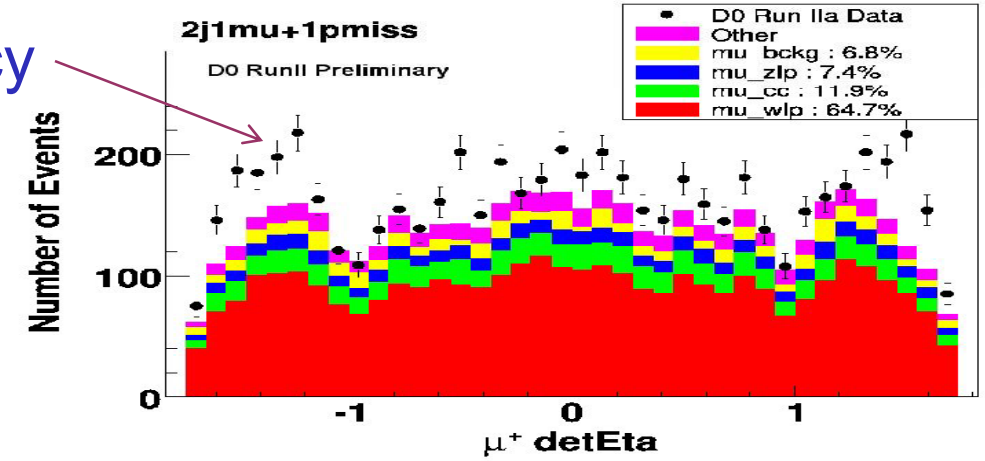
24 shape discrepancies after trials

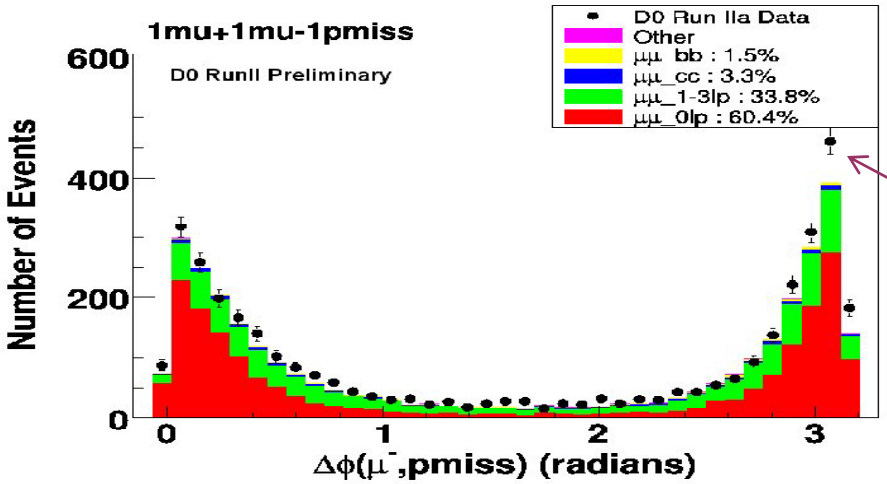
Modeling Discrepancies

η -dependent trigger efficiency

single μ

μ + jets





Track resolution modeling

high p_T μ and MET back-to-back

appears again in Sleuth

Sleuth: *quasi-model independent search*

Tails of Σp_T

for each final state

Cut to maximize excess

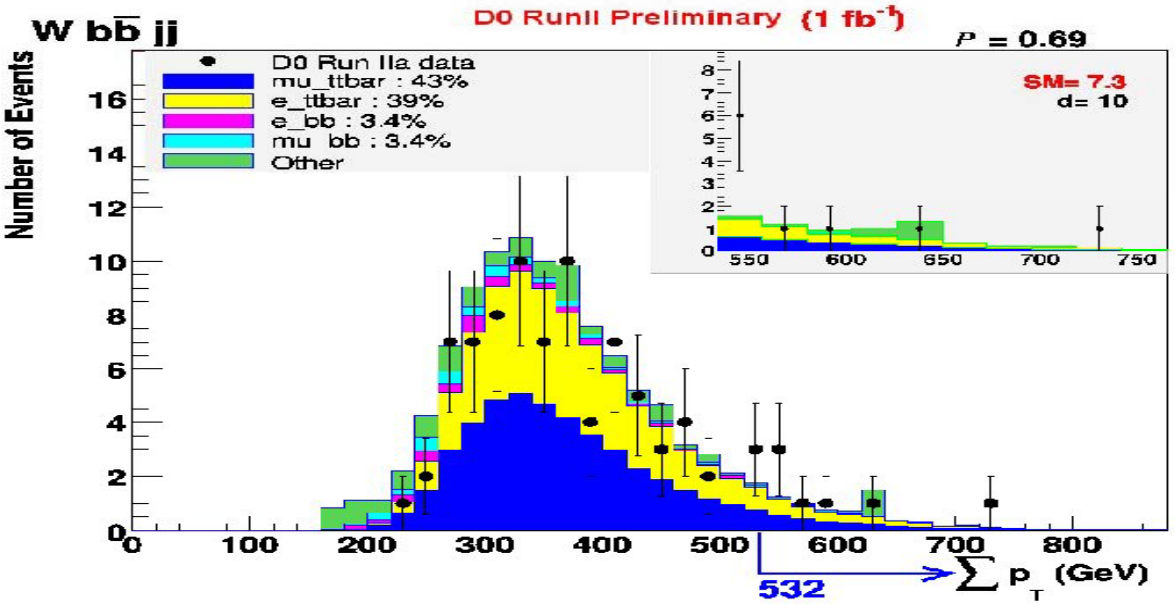
1-sided region

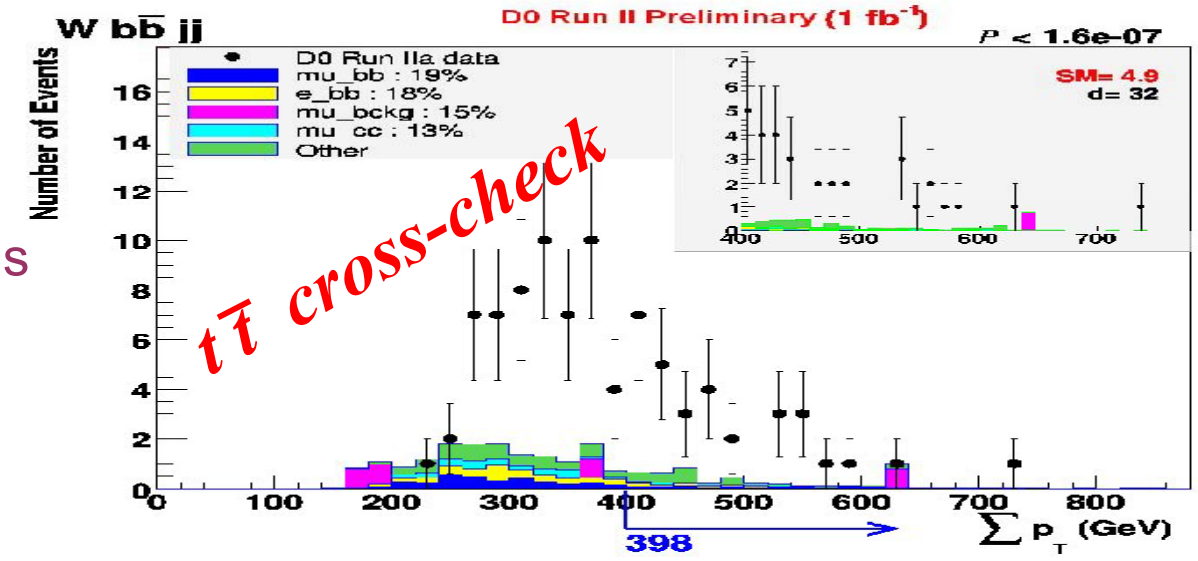
check each data point

Pseudoexperiments

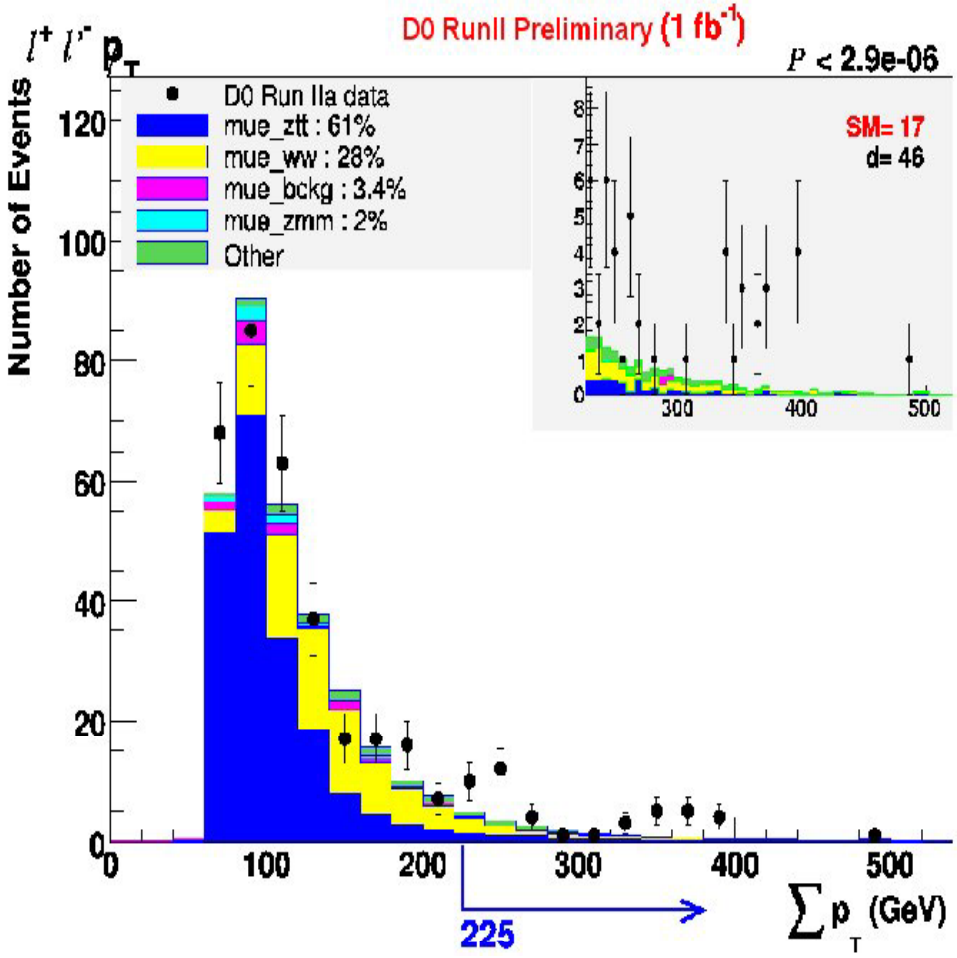
to find significance

Require < .001 after trials





Sleuth Results



OS μ e MET

Events in tails

large μ p_T

back-to-back with MET

same problem as μ μ + MET

Vista number excesses also trigger Sleuth

μ + 2 jet + MET

in bulk of distribution

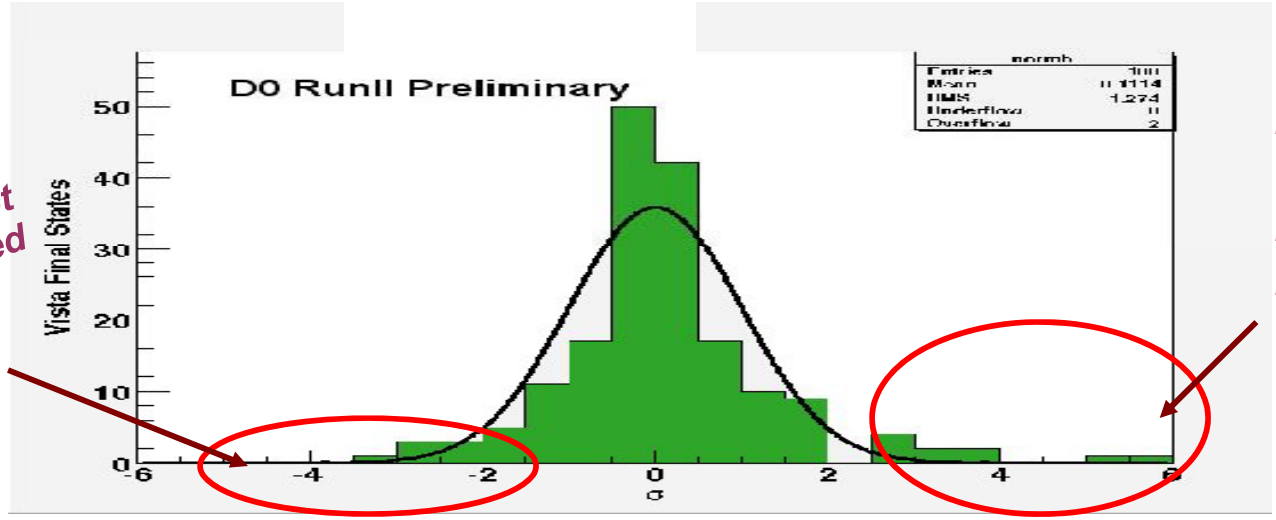
Additional Sleuth Results

D0 Run II Preliminary

Final State	*Pre Trials*
$e^+e'^- + \text{MET}$	.0000029
$e + \text{MET}$	.00082
$e^+e'^-$	.0031
$e^+\tau^- + \text{MET}$	.006
$e^+\tau^+$	.0066

Only state < .001 after trials

All most significant states have μ resolution issues



Background not overestimated

high σ; many with μ resolution issue

Conclusions

Most states and distributions agree with Standard Model

Vista considers counts and shapes

4 population, 24 shape discrepant distributions in 1 fb^{-1}

All these point to modeling difficulties

Sleuth looks for high-p_T excesses

One Sleuth discrepancy

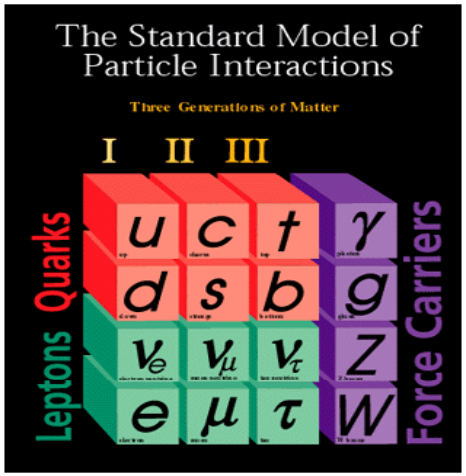
probably related to μ resolution

No hints yet... but with 5.0 fb^{-1} of data already collected, there is much more data to search!

Backup

The Standard Model is incomplete. With shrinking resources at Fermilab, we must address a central question:

Do we see what we expect?



Outline

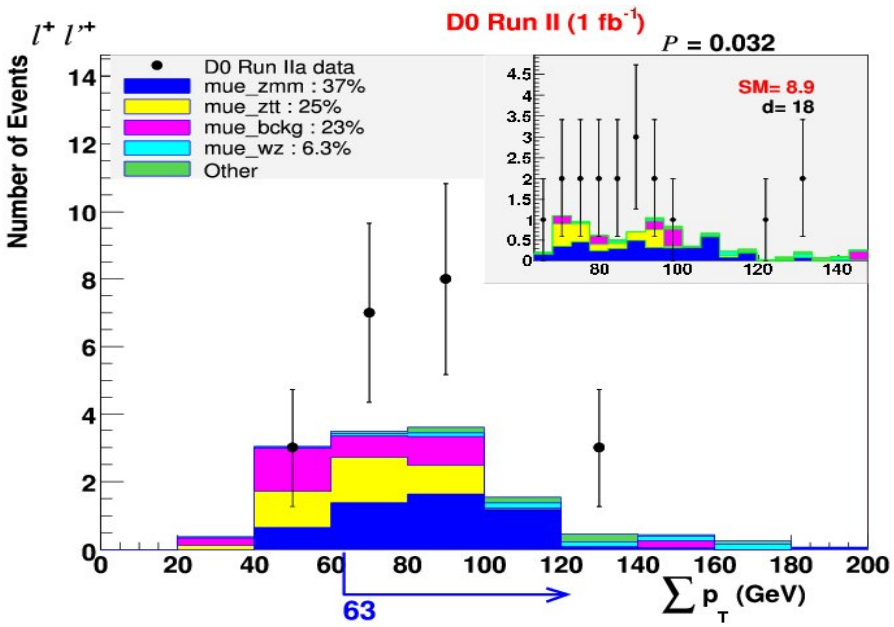
Search Strategy

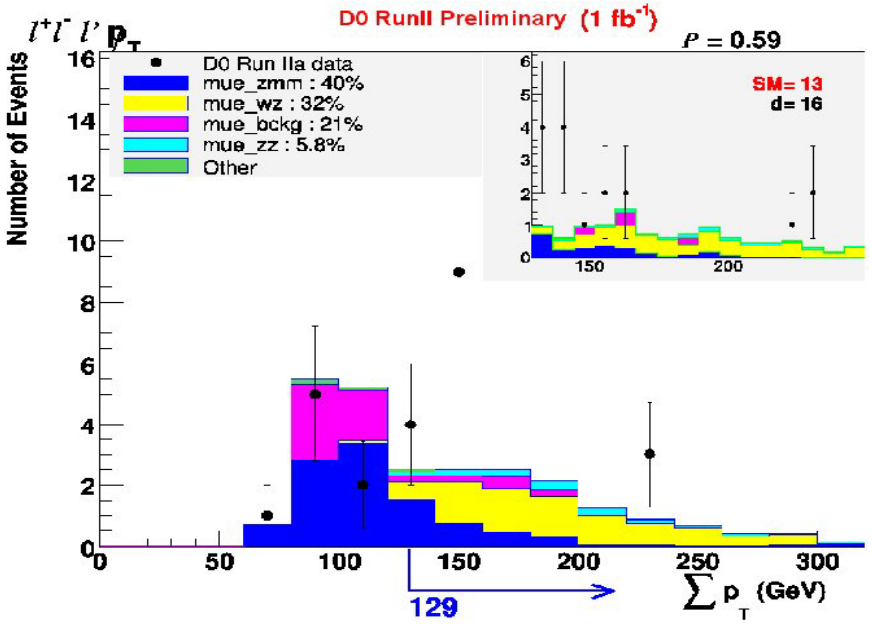
General Searches using Vista

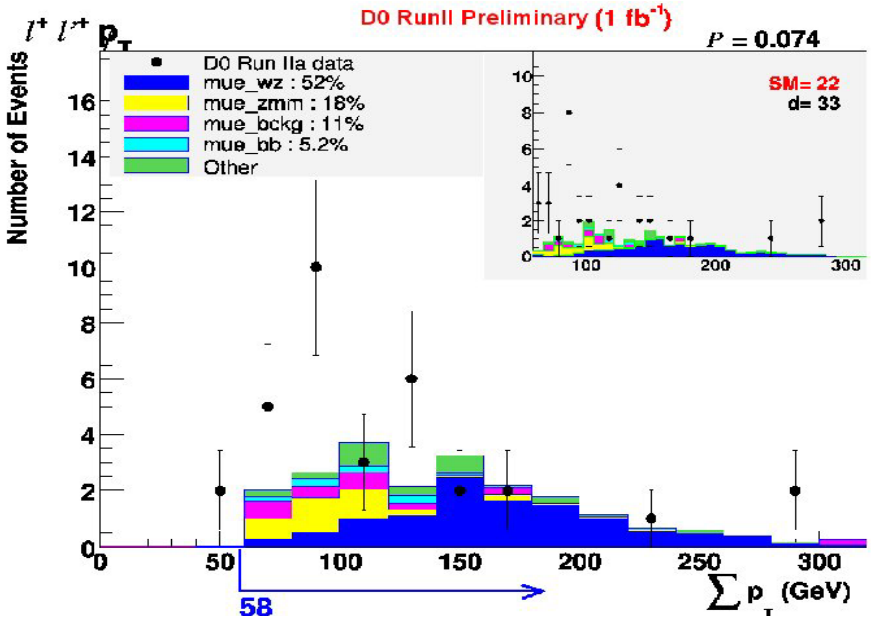
Targeted Searches using Sleuth

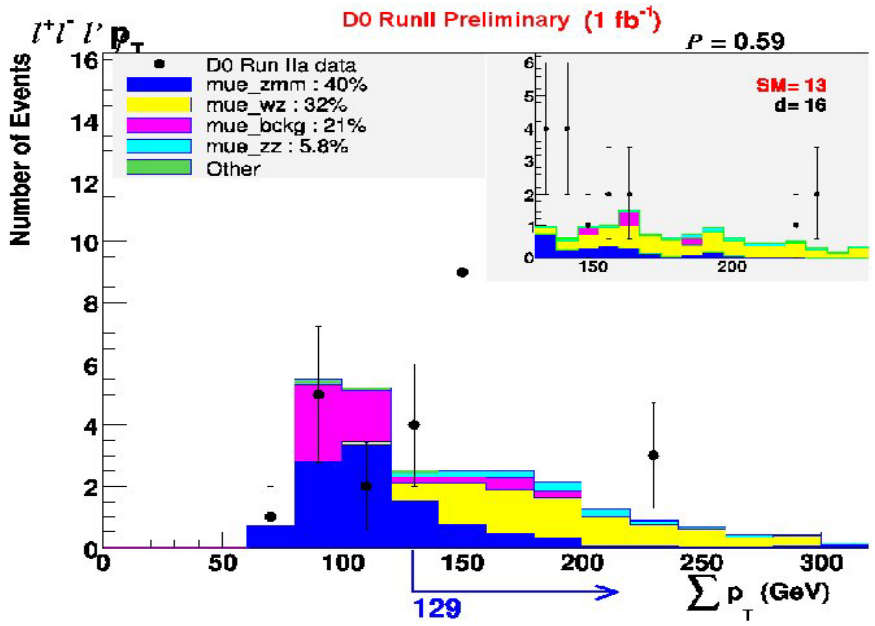
?

D0 Results for CDF Most Discrepant States

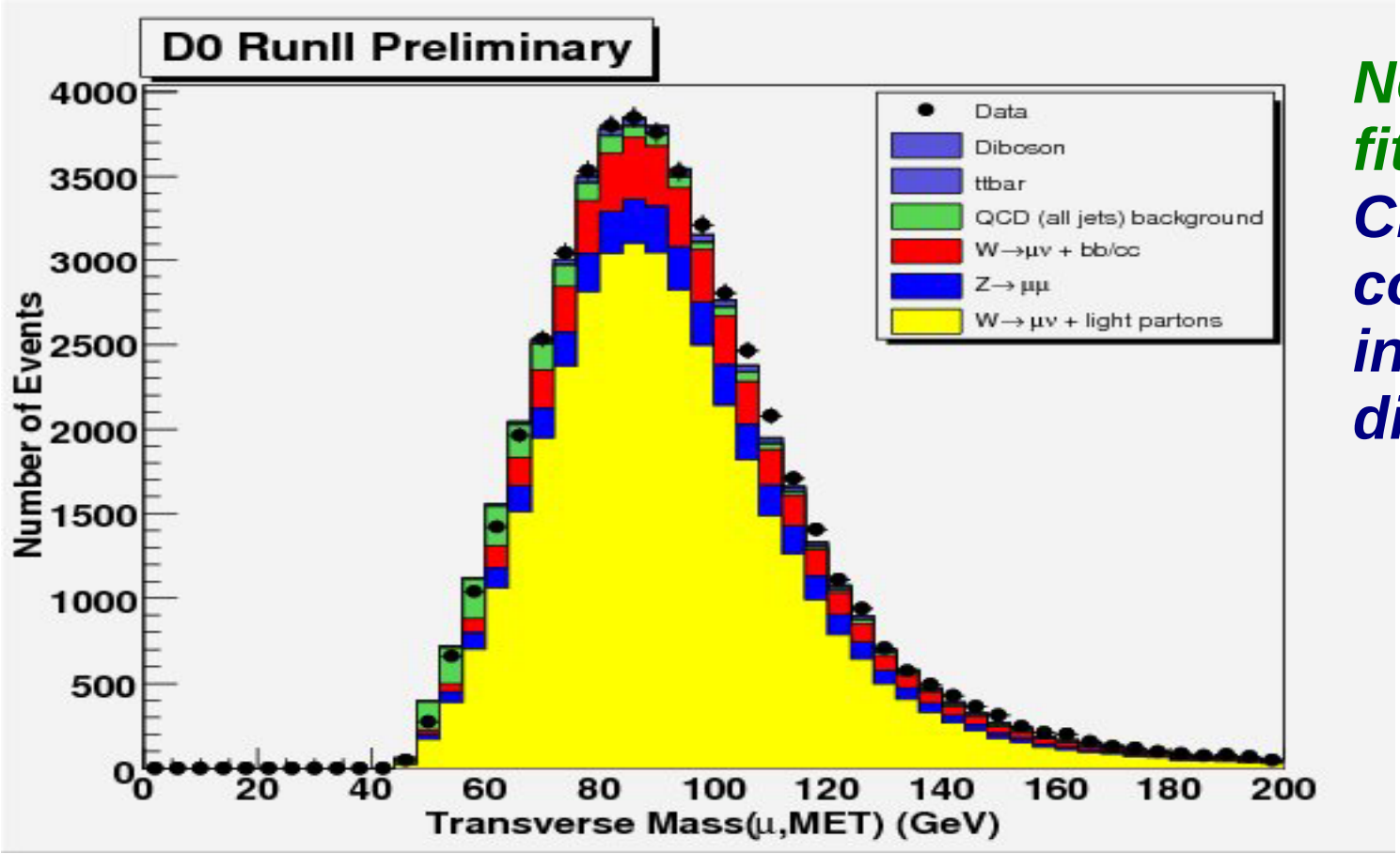








D0 MIS Checking Histogram



Not used in fit

Check for consistency in bulk of distribution