Update on WZ' Search

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Overview

This is the first record of the combined $WZ' \rightarrow lljj$, $WZ' \rightarrow lll\nu$ framework.
Don't expect this to be permanent.

Blame Chain

We have established the basic chain for assigning blame for the slow progress in this analysis.

- Frank will blame Matt.
- Matt will blame Rami.
- Rami will blame Elliot.
- Elliot will blame the ATLAS schedule.
- ATLAS will blame the CERN Accelerator Division.

Conclusion: This analysis has been delayed because of the CERN accelerator division.

Regions

I anticipate using three regions in M_{ll}:

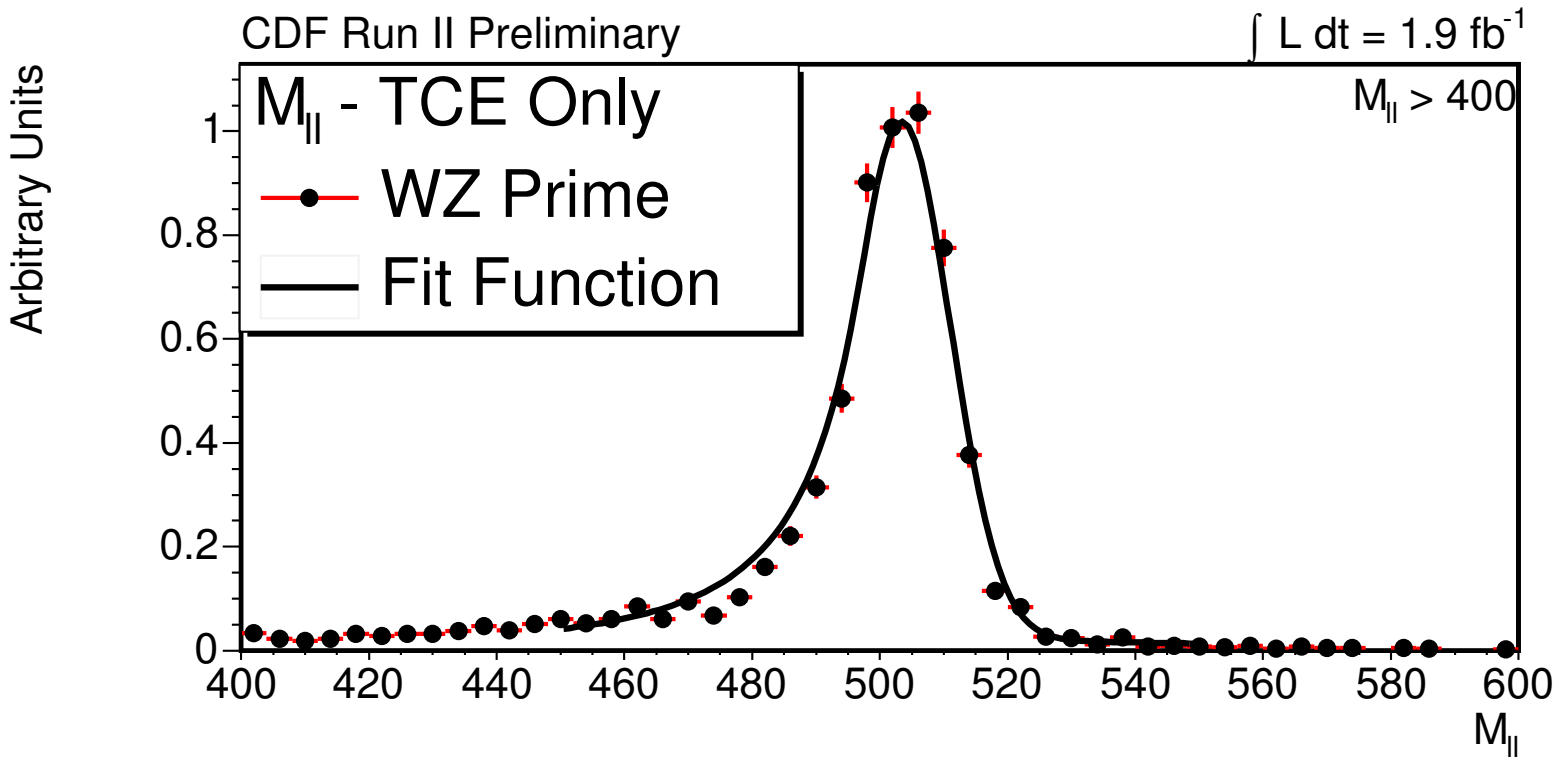
- Drell-Yan region: $M_{ll} = (76, 106)$ GeV
- Control region: $M_{ll} = (106, 400)$ GeV
- Signal region: $M_{ll} = (400+)$ GeV

- The Drell-Yan region will provide simple plots to confirm fake rates, MC handling, etc.
- The Control region will test our DY M_{ll} and M_{jj} shapes.
- The Signal region is that we expect to be dominated by out signal.

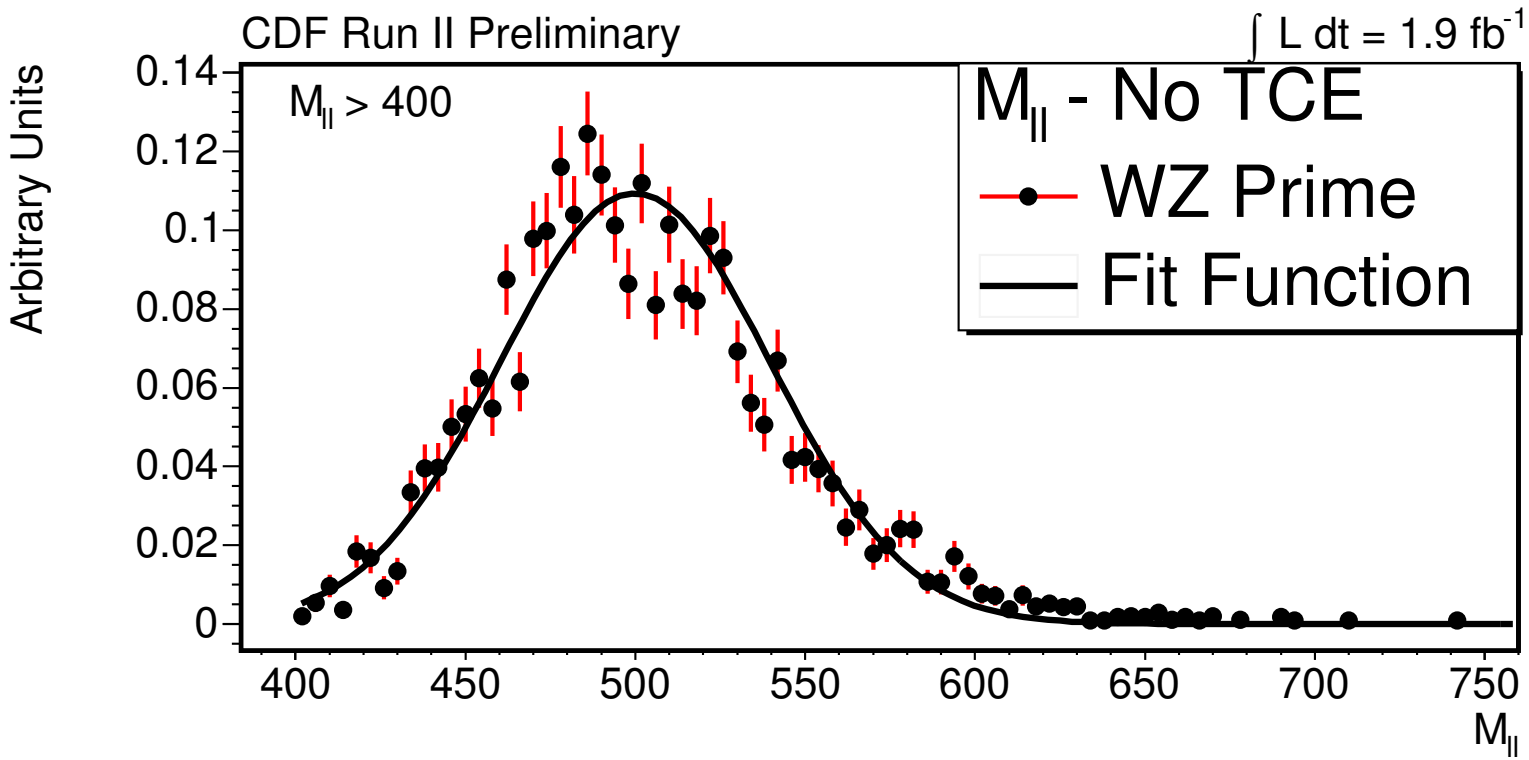
Signal Overview

- All Signal MC using Elliot's generated WZ' sample.
- Information on cross-sections taken from either Elliot or from Rami.

Electron M_{ll}



Muon M_{ll}


CDF Run II Preliminary
∫ L dt = 1.9 fb-1
Mll > 400
Mll - No TCE
WZ Prime
Fit Function
Arbitrary Units
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
400
450
500
550
600
650
700
750
Mll

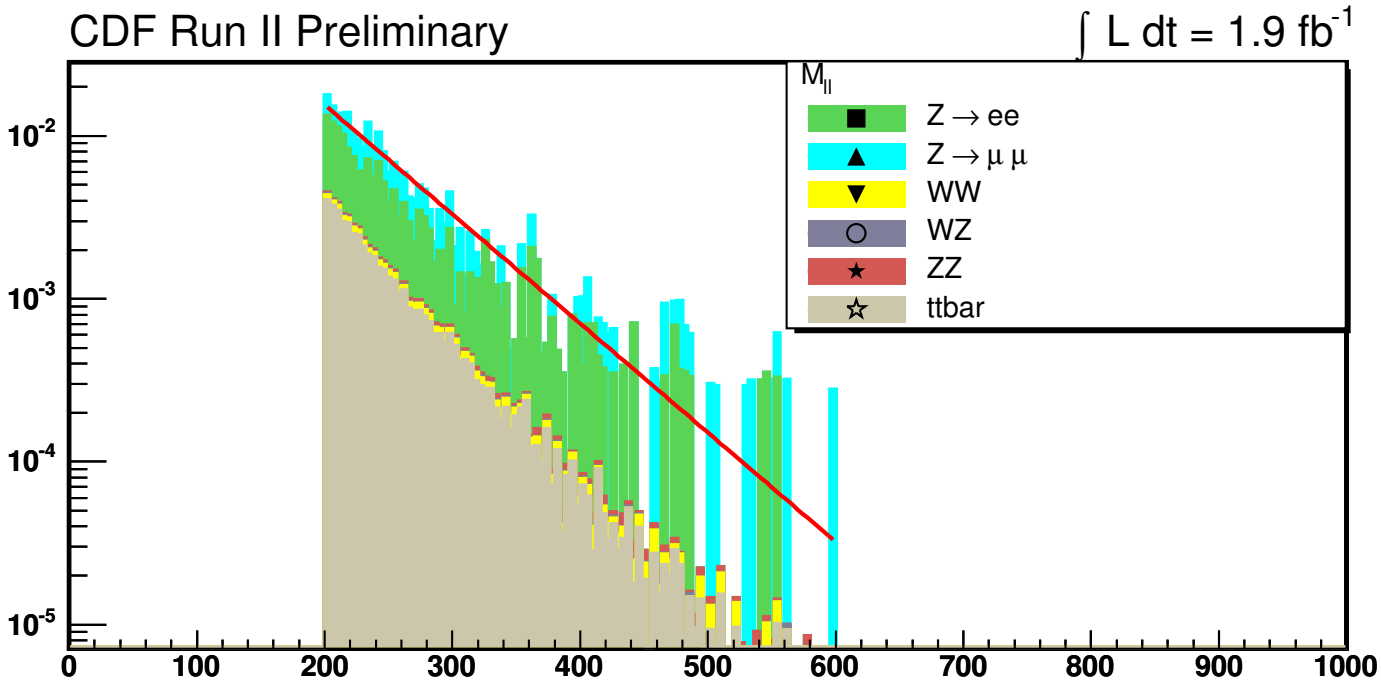
Background Sources

Background were taken from standard CDF Sample

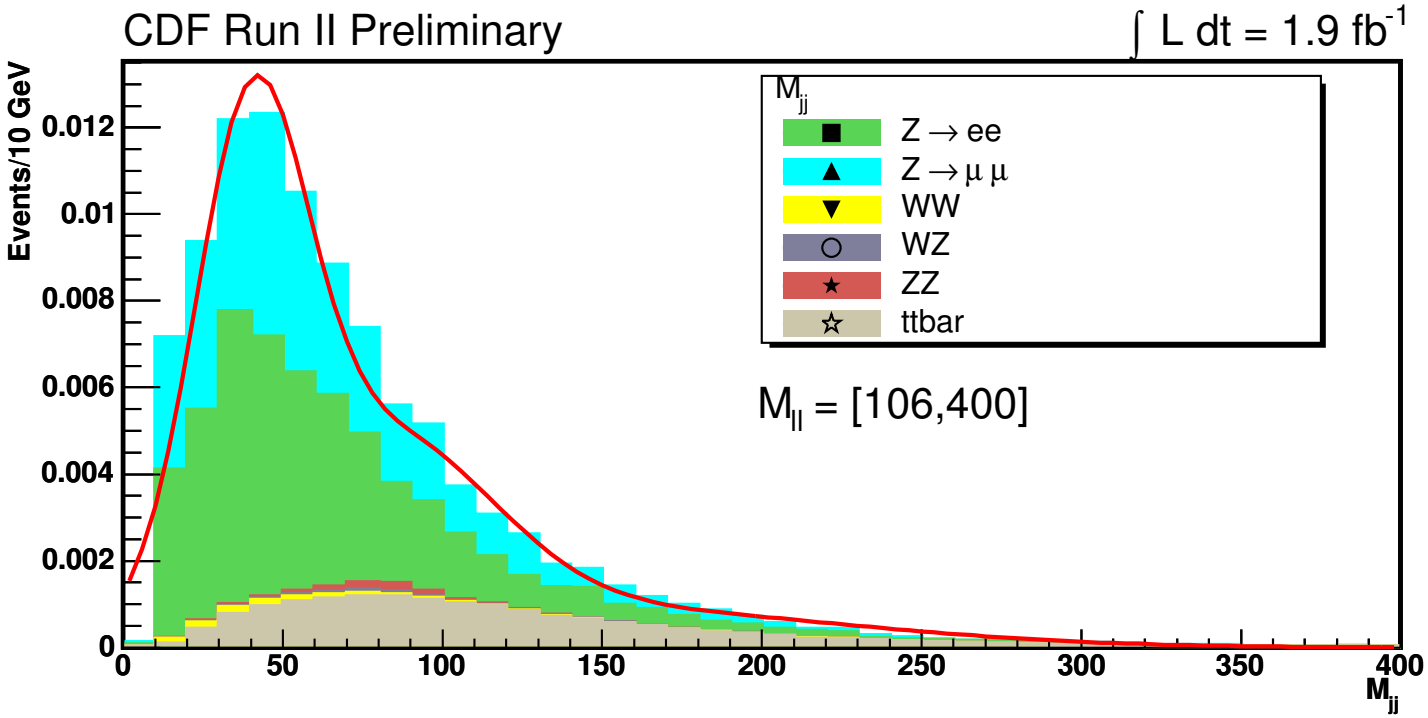
Background MC

- $Z \rightarrow ee$: ze1s6d, ze1sad, ze0scd, ze0sdd, ze0sed, ze0see
- $Z \rightarrow \mu\mu$: ze1s6m, ze1s9m, ze0sbm, ze0scm, ze0sdm, ze0sem
- WW: we0s5d, we0sbd, we0sgd
- WZ: we0s6d, we0scd, we0shd
- ZZ: we0s7d, we0sdd, we0sid
- $t\bar{t}$: te0s2z

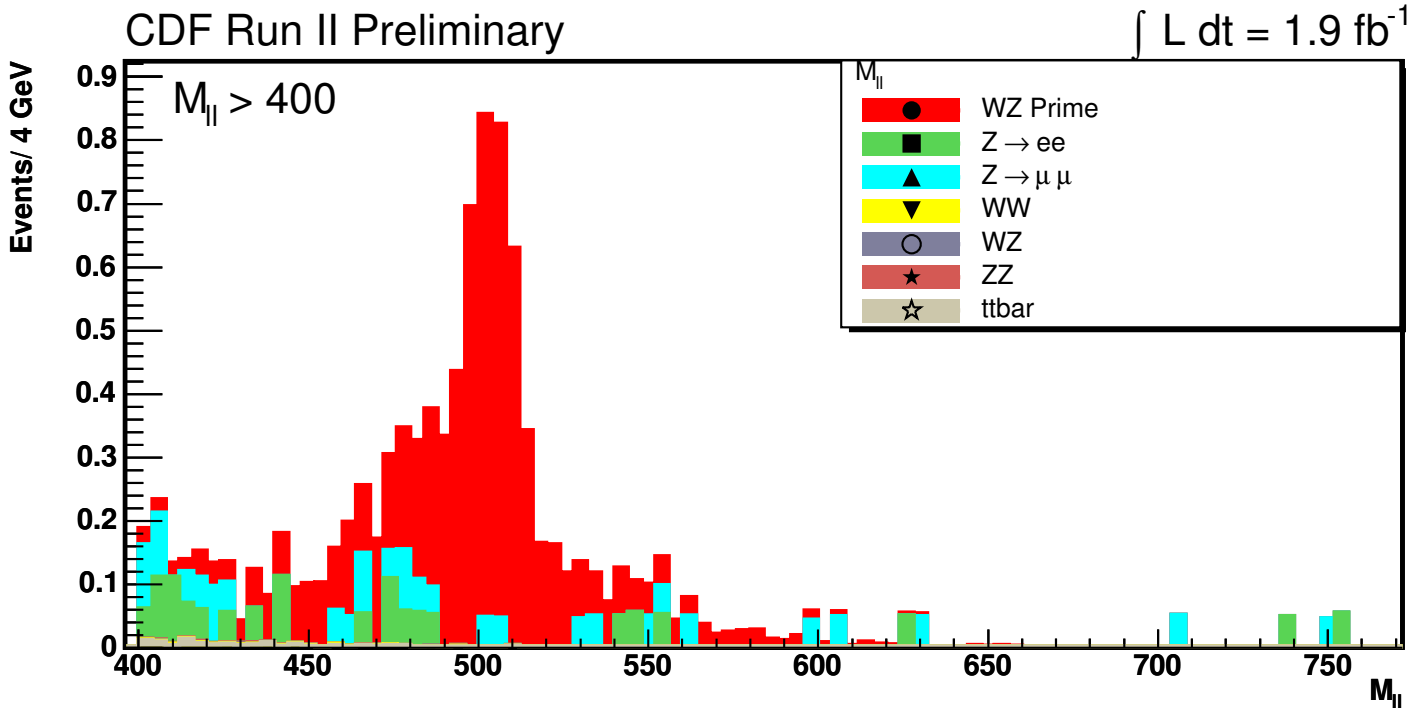
Background M_{ll} for $WZ' \rightarrow lljj$



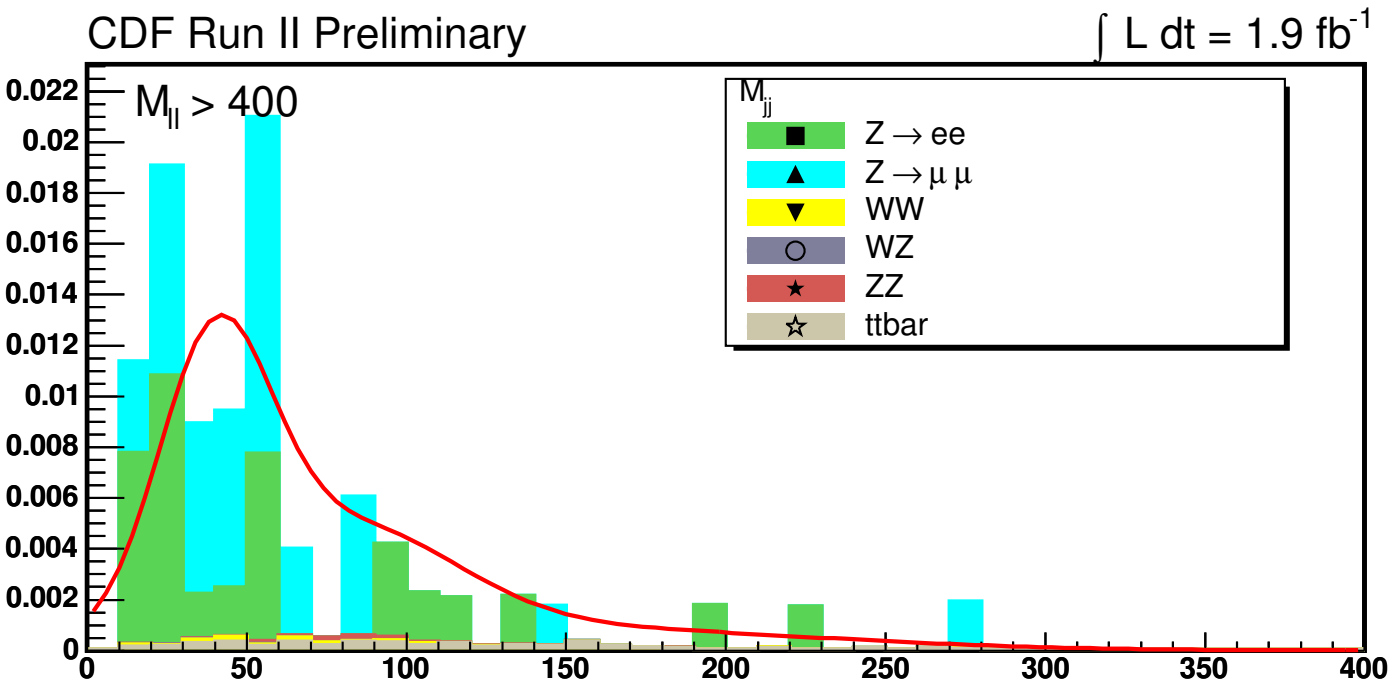
Background M_{jj} for $WZ' \rightarrow lljj$



M_{ll} in the Signal Region for $WZ' \rightarrow lljj$



M_{jj} in the Signal Region for $WZ' \rightarrow lljj$



Background for $WZ' \rightarrow lll\nu$

Events expected in $3fb^{-1}$ dataset

- ZZ: 0.0002
- WZ: 0.0018
- $Z\gamma$: 0.0051
- $Z + jets$: 0.0001
- $t\bar{t}$: 0.0009
- $W\gamma$: 0.0011

Overview

- Use unified test statistic for $WZ' \rightarrow lljj$ and $WZ' \rightarrow lll\nu$
- Be responsive both to excess events.
- Be able to scan over different central masses.
- Produce unified result.

Test Statistic

We choose a test statistic for our analysis of the following form:

$$S = \prod_N \frac{sf \times P_s + (1 - sf) \times P_b}{P_b}$$

where:

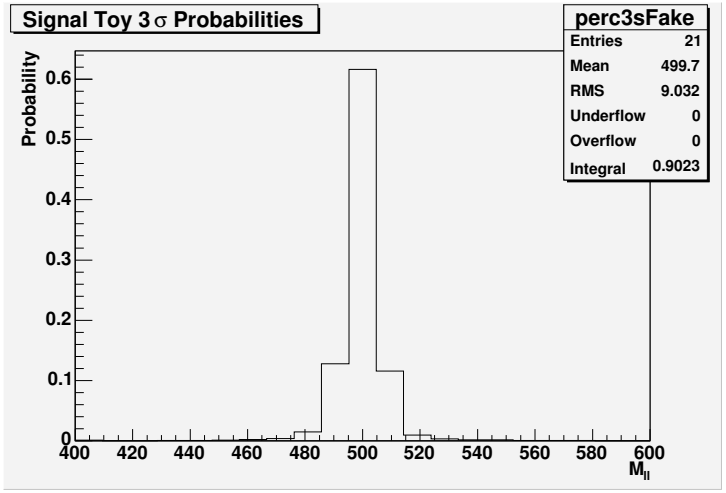
$$P = P_{ll} \times P_{jj} \text{ for signal and background in } WZ' \rightarrow lljj$$
$$P = P_{ll} \text{ for signal and background in } WZ' \rightarrow lll\nu$$
$$\text{sf = Signal Fraction} = \frac{N_{data} - N_{MCbackground}}{N_{data}}$$

and P_{ll} and P_{jj} are the probabilities for the dilepton and dijet mass distributions respectively, while N is the number of events.

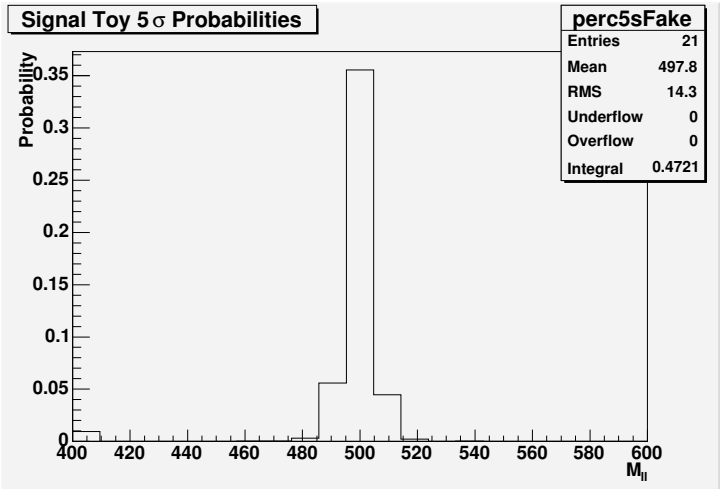
Procedure

- Produce a large number of background toys in both $WZ' \rightarrow lljj$ and $WZ' \rightarrow lll\nu$.
- For each toy, calculate the test statistic.
- Calculate the test statistic values for 3 σ and 5 σ.
- Create a number of signal toys.
- For each signal toy attempt to fit for multiple M_{ll}. Pick the best test statistic.
- Calculate the percentarge of signal events higher then the background 3 σ and 5 σ cutoffs.

lljj Results

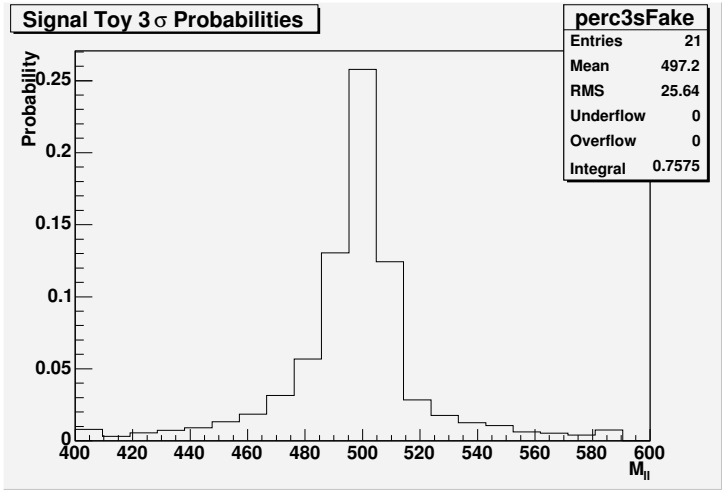


3 σ

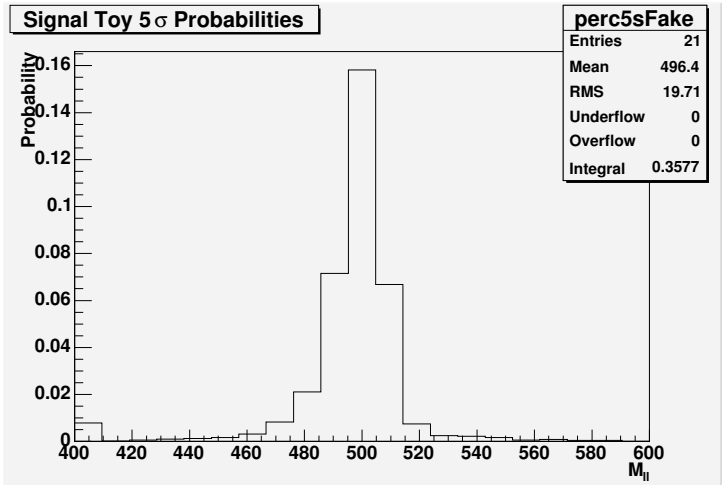


5 σ

lllν Results

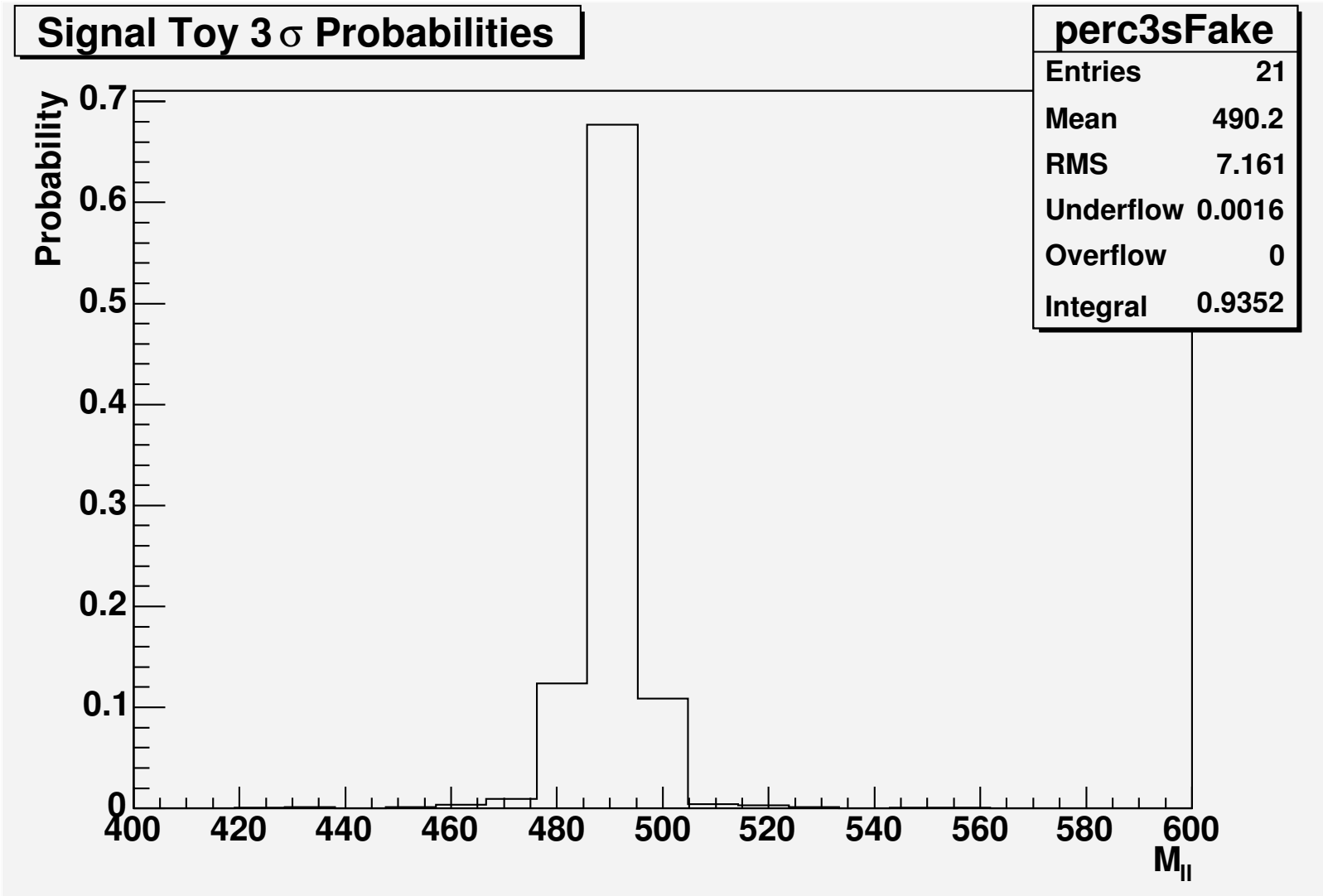


3 σ

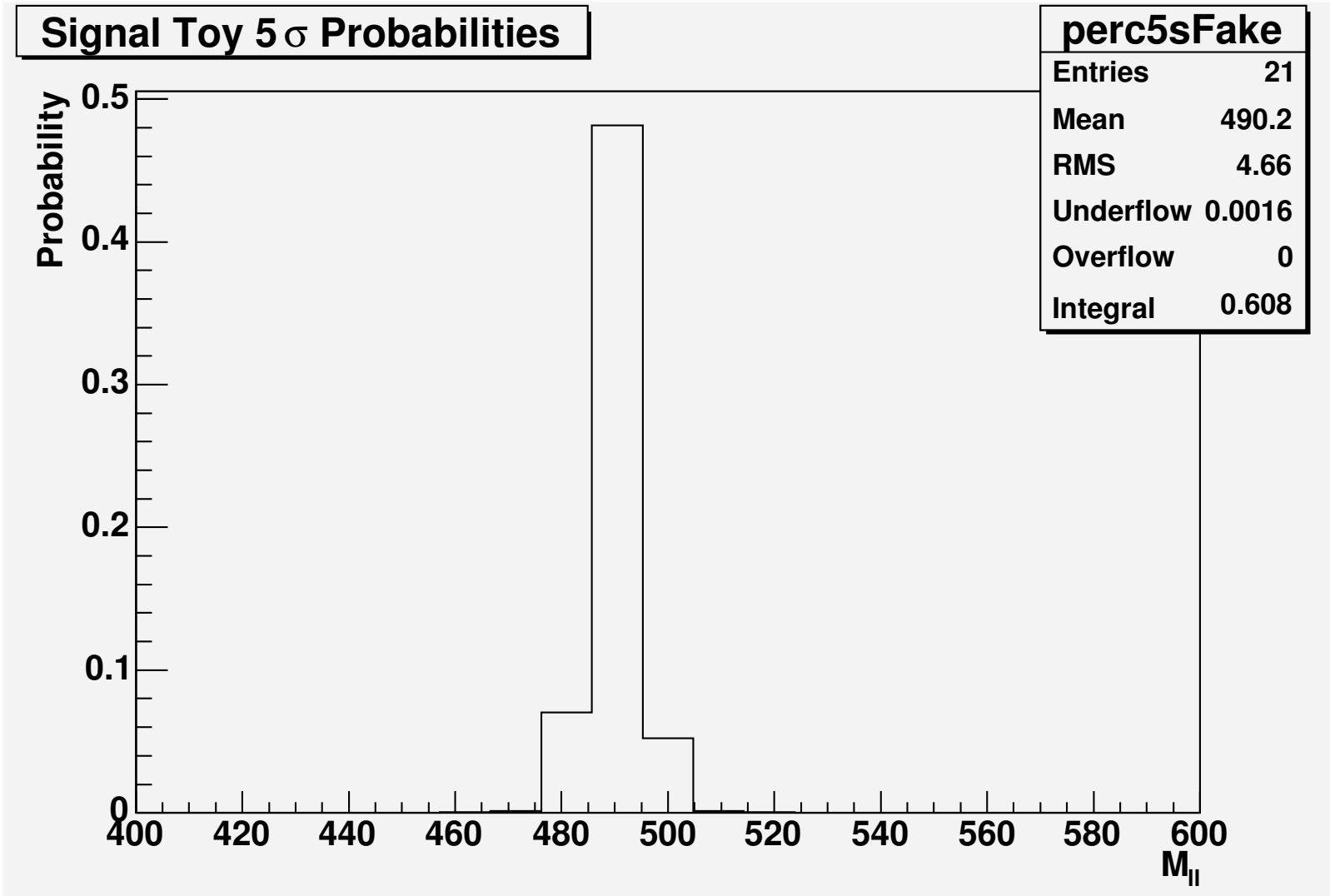


5 σ

Combined 3 σ Result



Combined 5 σ Result



Systematics Overview

Jet Systematics

- JES: Create template using the shift from the ZZ aTGC analysis.
- Jet Resolution: Create template by smearing each jet by a 10% Gaussian.

Lepton Systematics

- Lepton Shape: Increase the σ values of the dilepton templates by 5%.

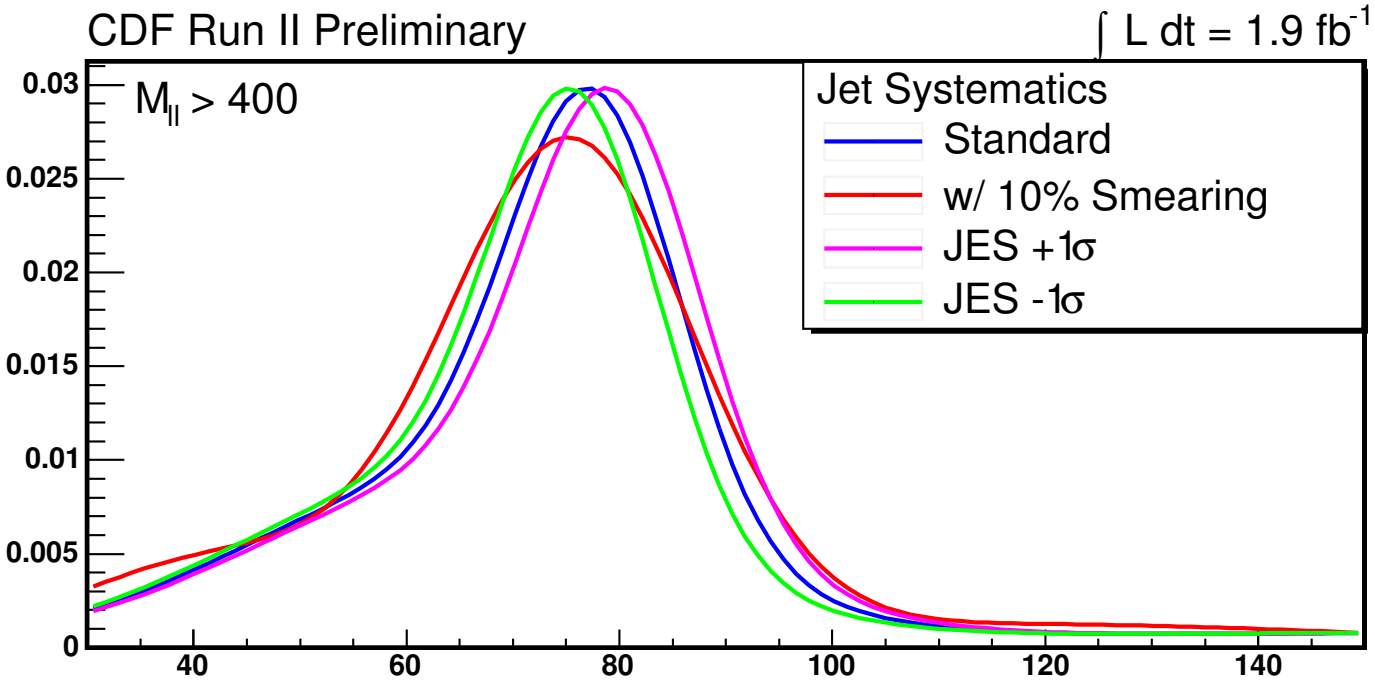
Cross-Section Systematics

- Signal: Vary the Signal cross-section?
- Acceptance: 8%, taken from ZZ/WZ aTGC Blessed result

Background Systematics

- Z+Jets: Increase the Z+Jets cross-section by 100%

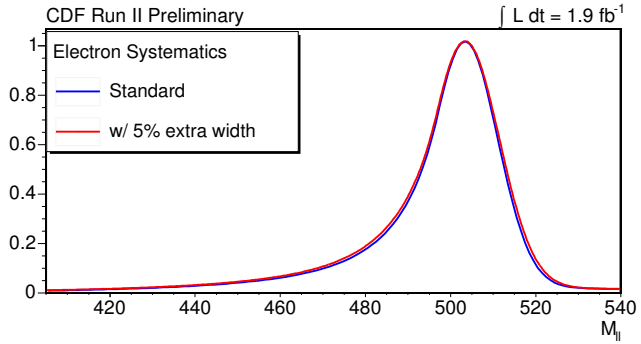
Jet Systematics

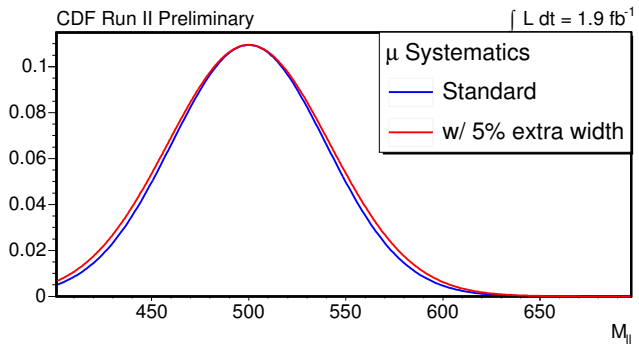


I believe that the Jet Resolution systematic is dominant, so I will be using only that one.

Lepton Systematics

I must confess that this has no other purpose then to see how the analysis reacts to a slight variation in lepton shape.





Z + Jets Systematic

We handle the uncertainty in the Z + Jets contribution by increasing the cross-section for expected background events by 100%.

Rationale: Because I can (Z + Jets is the most insignificant of the trilepton backgrounds).

Acceptance

dilepton:	
pdf	2%
lepID	1.5%
trigger	0.3%
dilepton total	2.5%
dijet:	
JES	3%
jet resolution	0%
ISR	2%
FSR	3%
dijet total	4.7%
luminosity	6%
Grand Total	8.0%

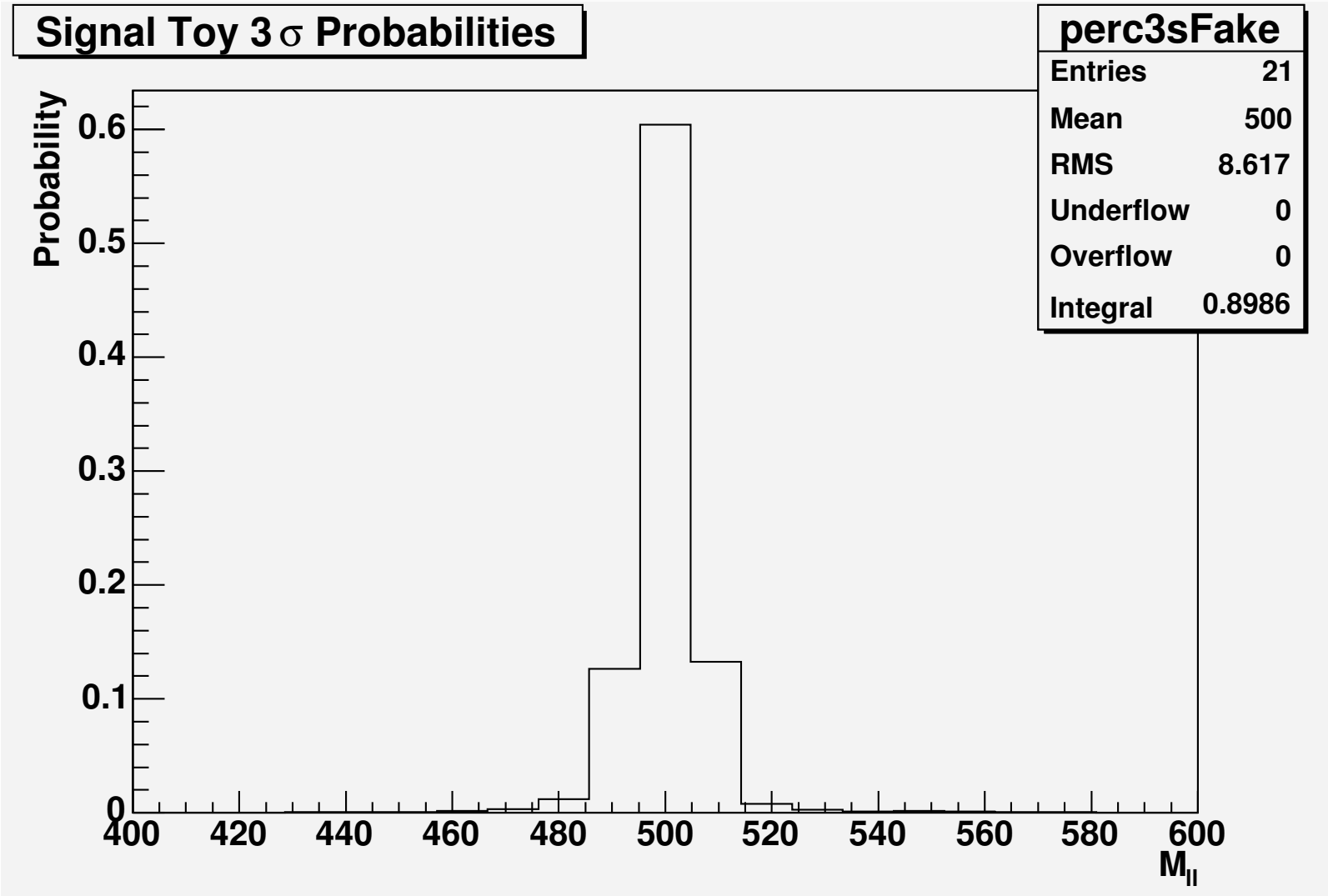
Table: Acceptance Systematics from CDF8719 and CDF9216

Cross-Section Systematics

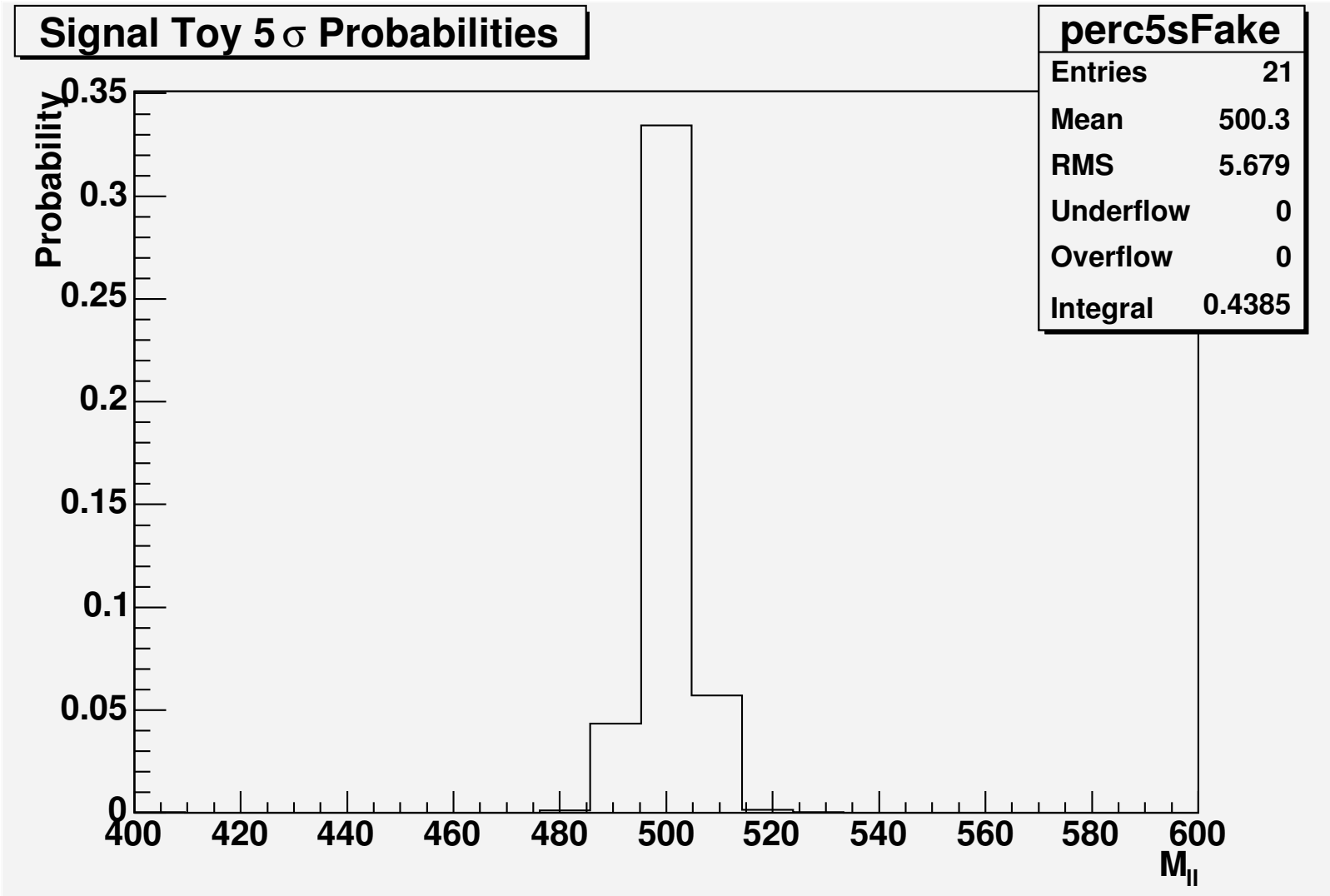
If we are attempting to make a search for the event we saw already, it would make sense to create a systematic on the cross-section.
However, the Poisson lower limit on a cross-section of 1fb, given 1 event, is 0.105fb(*) at the 90% CL. This is too low to give a practical analysis.
Since we are more or less searching for a cross-section, I propose skipping a cross-section systematic entirely.

* See PDF 32.3.2.5 for a more detailed discussion.

Combined 3 σ Result w/ Sys.



Combined 5 σ Result w/Sys



How to Get a Limit

- For data, find the M_{ll} value with the best (highest) test statistic.
- Use toy MC to generate multiple cross-sections for that value of M_{ll}
- Find the cross-section for which exactly 95% of signal events are above that value.
- If the probability of background creating this event is less then 3σ, call this out limit.

To Do

- We need Elliot's code.
- We need MC out to 3fb^{-1}
- We need a better grasp of how to handle systematics.
- We need prettier plots.