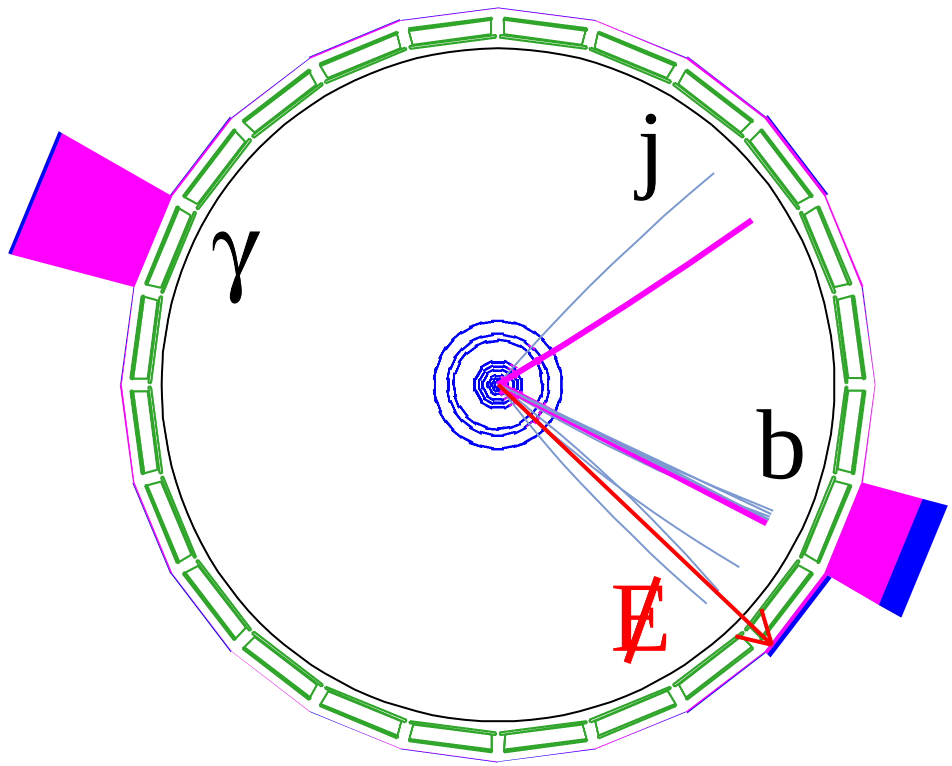
Search for New Physics in the $\gamma + b + j + \not\!\!E_T$ Channel at CDF



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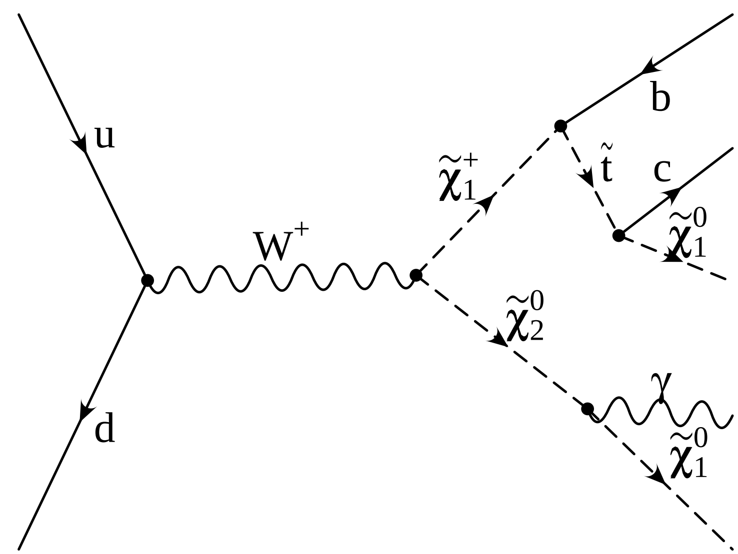
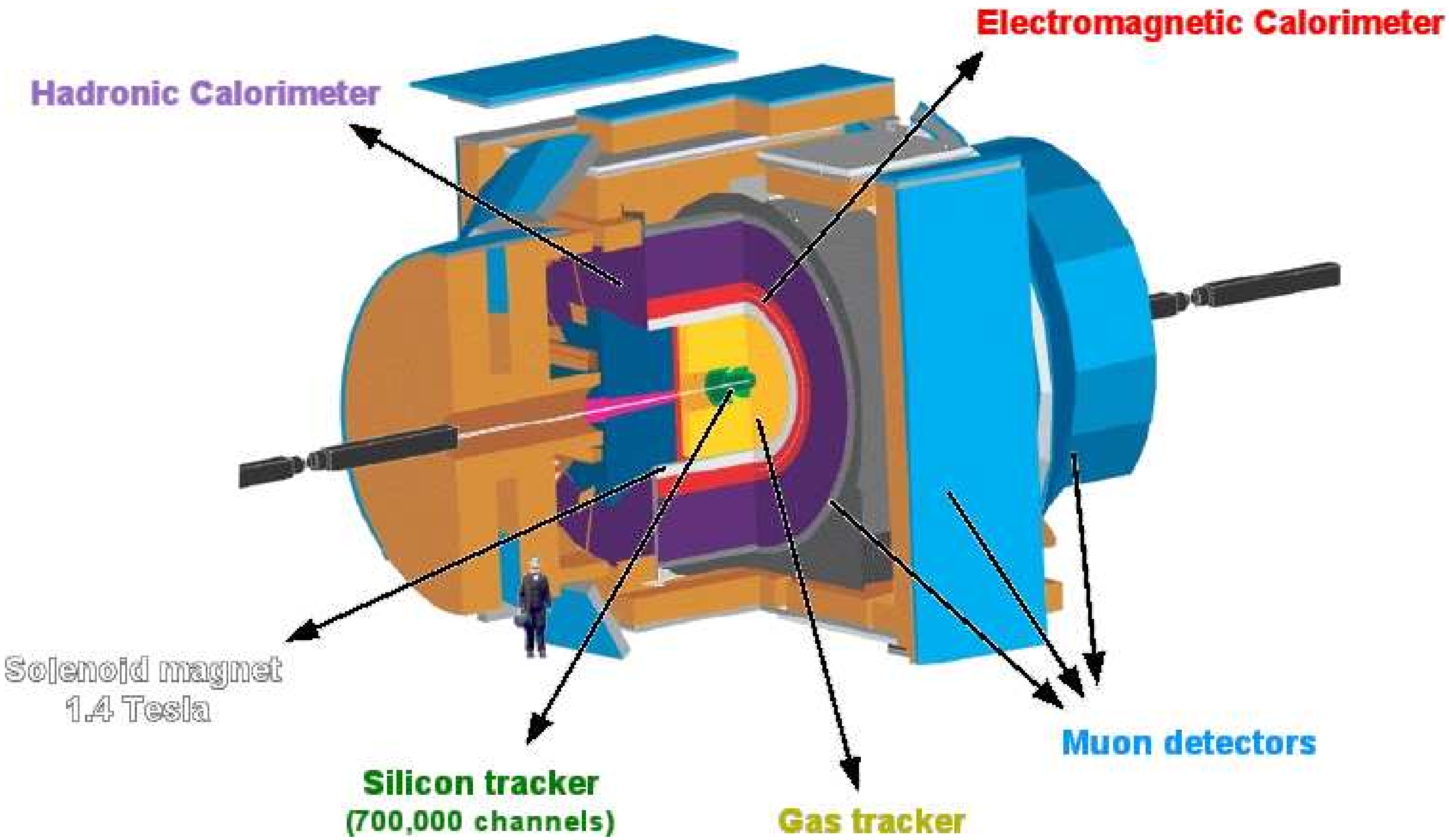
on behalf of the CDF Collaboration

Introduction

- Signature-based search: no specific model
- One possible contributor: chargino - neutralino production (SUSY)
- No SM background in this channel
- We agressively cut away mismeasured events

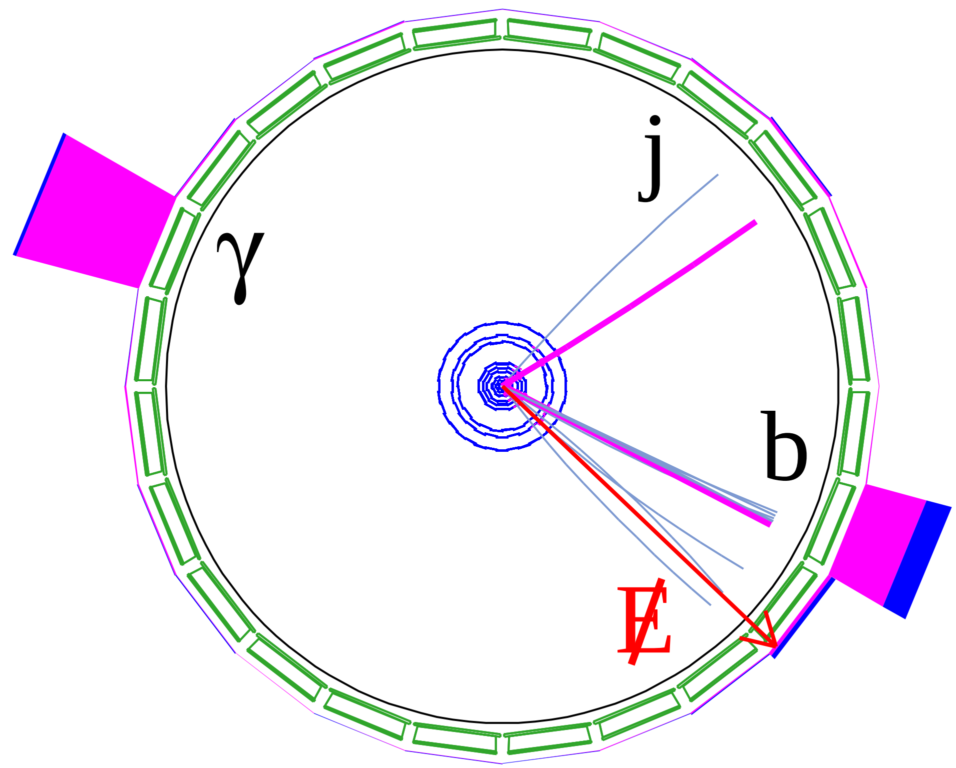


The Detector

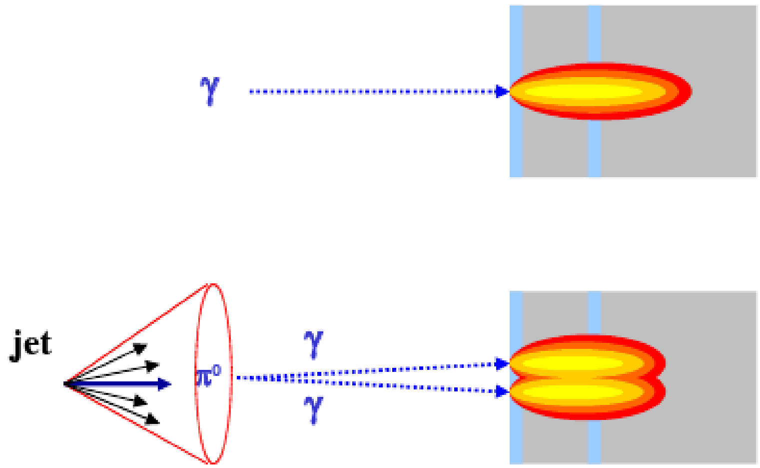


Event Selection

- Required a photon with $E_T > 25$ GeV
- Required at least two jets with $E_T > 15$ GeV
- Required at least one jet tagged as a b quark
- Required $\not\!\!E_T > 25$ GeV
- Required $\Delta\phi$ between jet and $\not\!\!E_T$ at least 0.3 radians



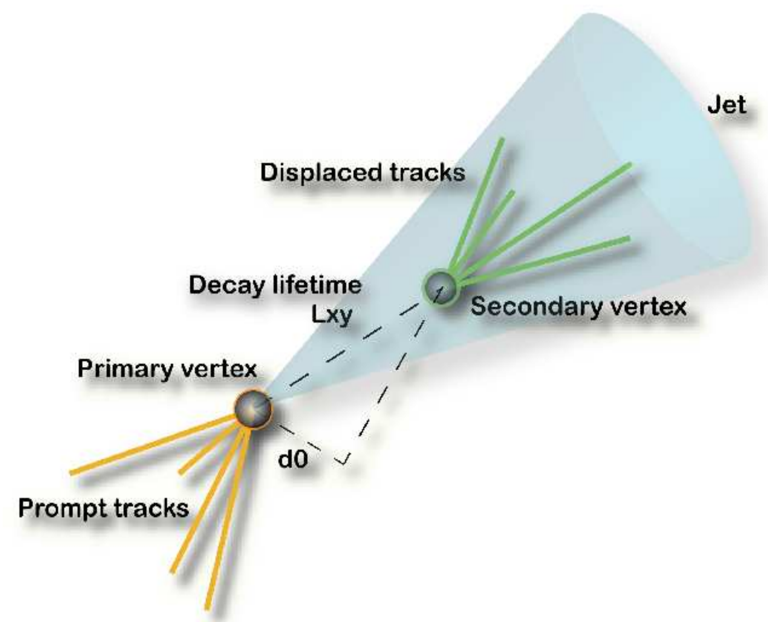
Fake Photon Background



- $\pi^0 \to \gamma\gamma$ can cause a jet to fake a photon
- For low-energy pions, the two photons hit a larger area in the strip chamber
- One photon has 65% chance to convert in preshower radiator, two have 85% chance for at least one to convert
- We get a statistical weight for each event: gives fake fraction in a large sample

Fake b-jet Background

- Tracks in a b-jet originate from a displaced vertex
- Other long-lived particles (Λ, K_s) or imperfect track reconstruction can fake a b-jet
- We look at properties of each jet, determine chance of erroneously b-tagging it



We applied these weights to the (pretag) sample to get the fake b-tag background

Fake Missing Energy

- No SM process generates $\gamma + b + j + \not{E}_T$
- Principal source of $\not{E}_T$ is mismeasurement of jet energy
- In these cases, $\not{E}_T$ will point along the mismeasured jet
- We cut away events where the $\not{E}_T$ is too close to a jet

Main Backgrounds

	Real γ	Fake γ
Real b-tag	A	B
Fake b-tag	C	D

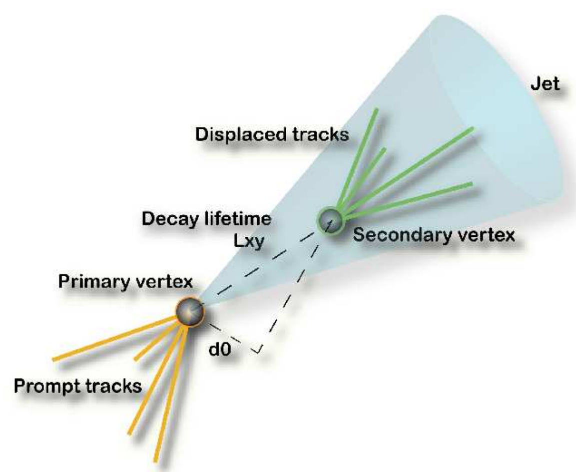
A: Used Madgraph Monte Carlo

B and D: Applied fake photon weight to tagged sample

C: Applied mistag matrix and real photon weight to untagged sample

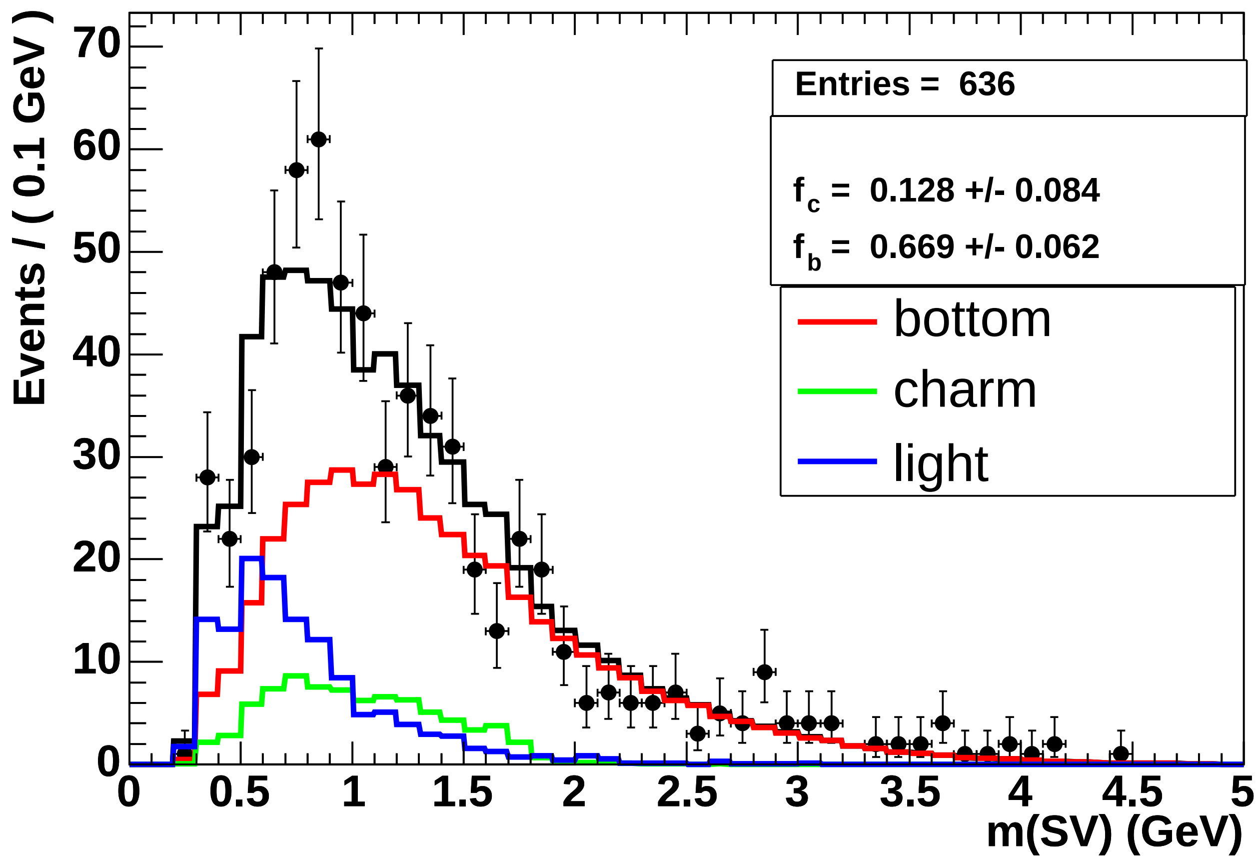
Monte Carlo Background

- Used Madgraph to generate $\gamma + b +$jets and $\gamma + c +$jets samples
- Used matching scheme to remove events that would double-count radiation
- Fit secondary vertex mass with contributions from γb, γc, and light flavor



- Used these numbers to normalize Monte Carlo

Monte Carlo Background



$$f_b = 0.47 \pm 0.02(\text{stat.}) \pm 0.08(\text{syst.})$$
$$f_c = 0.15 \pm 0.08(\text{stat.}) \pm 0.07(\text{syst.})$$

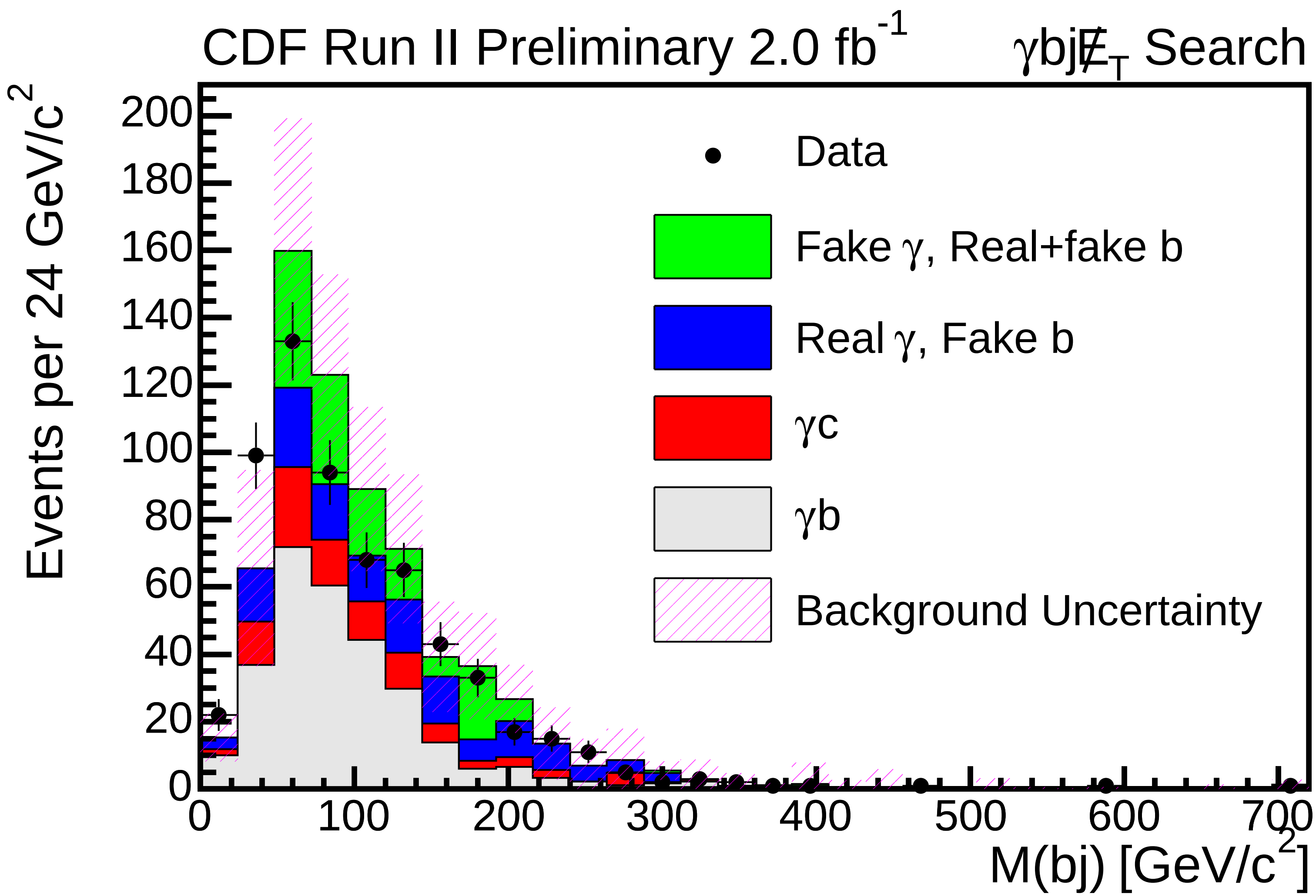
Predicted and Observed Events

Background Source	Predicted Standard Model Events	Statistical Uncertainty	Systematic Uncertainty
$\gamma + b + j$ MC	291	7	50
$\gamma + c + j$ MC	92	25	45
Fake b, Real γ	141	6	30
Fake γ	113	49	54

Predicted Events: 637 ± 54(stat.) $\pm\, 128$(syst.)

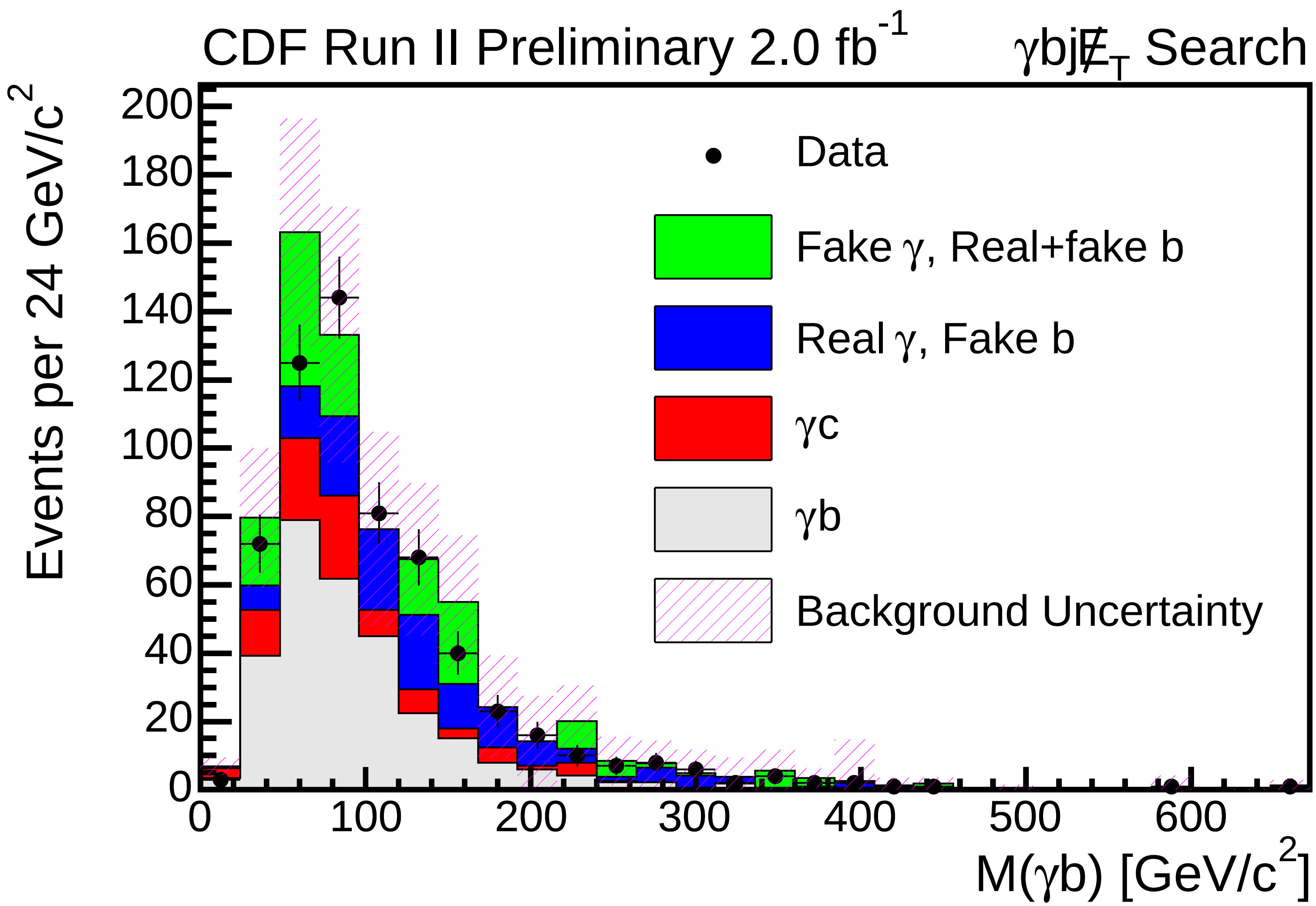
Observed Events: 617

Results



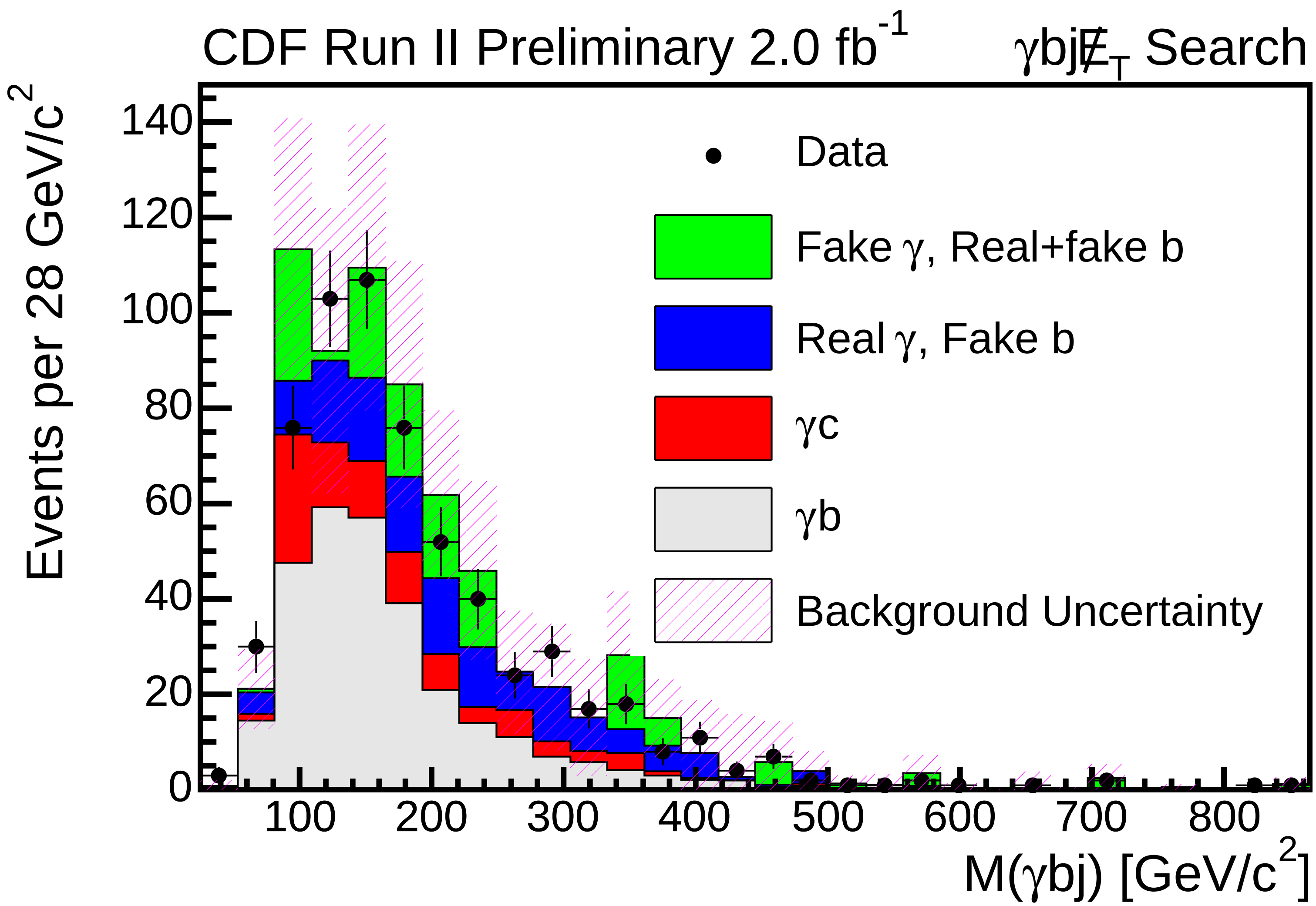
Mass of $b + j$

Results



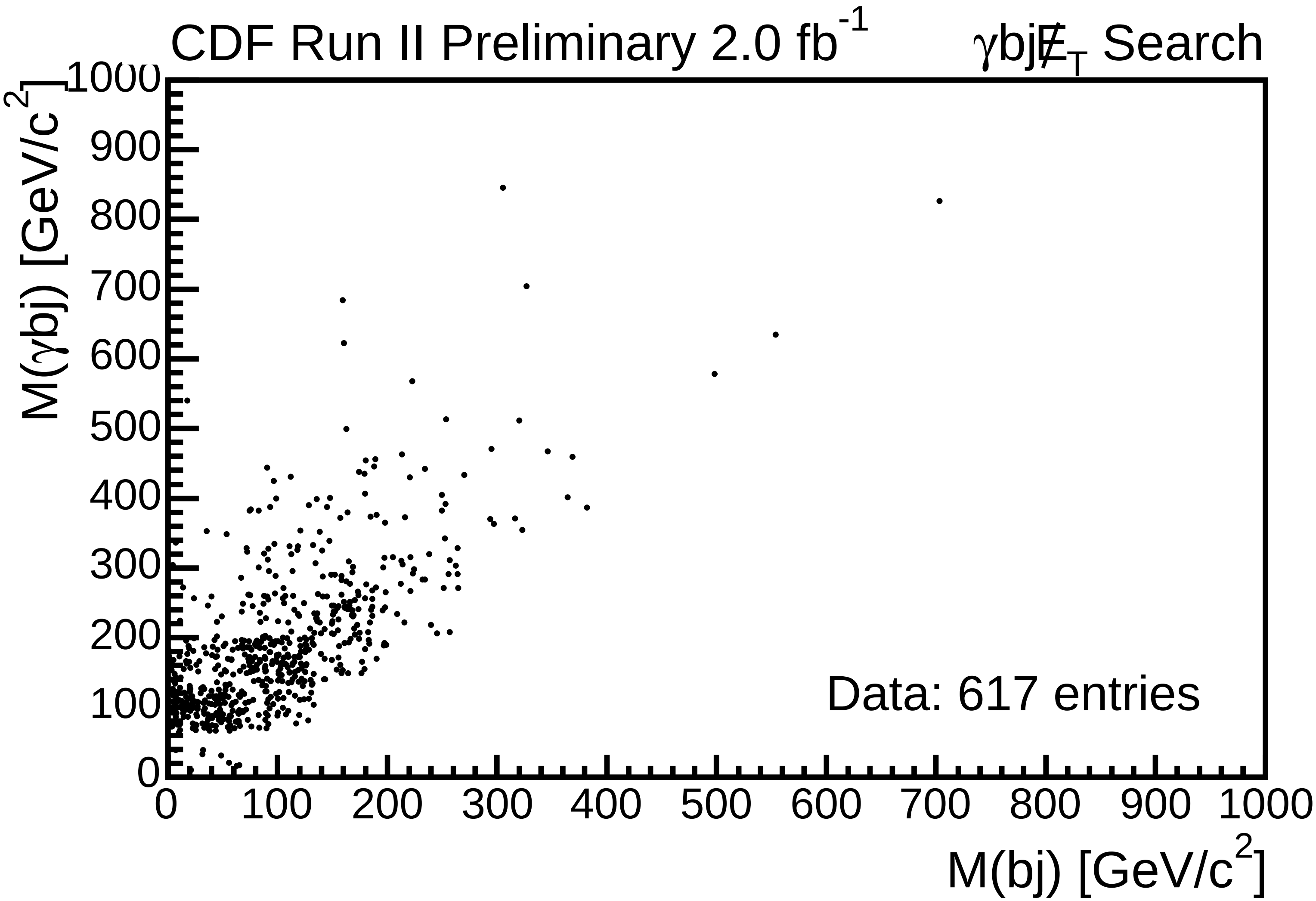
Mass of $\gamma + b$

Results



Mass of $\gamma + b + j$

Results



Mass of $b + j$ vs. mass of $\gamma + b + j$

Future Work

How do we communicate a signature-based result to the theorists?

- We generate a "standard candle" ($p\overline{p} \rightarrow W^- \; Z \rightarrow e^- \; \overline{\nu}_e \; b \; \overline{b}$), with the e^- changed to a photon
- We use CDF detector simulation to find our expected signal from this process
- Theorists can run MC of any new model and of our standard candle
- They can then scale their MC so that their standard candle matches ours
- This will give our expected sensitivity to their new model

Conclusion

- We looked for anomalous production of $\gamma + b + j + \not{E}_T$
- We cut away mismeasured events to the extent that we could
- We found that the number of observed events was consistent with the standard model background expectation
- We found that all kinematic distributions were consistent with the standard model background

In short: we see no evidence of new physics in this channel.