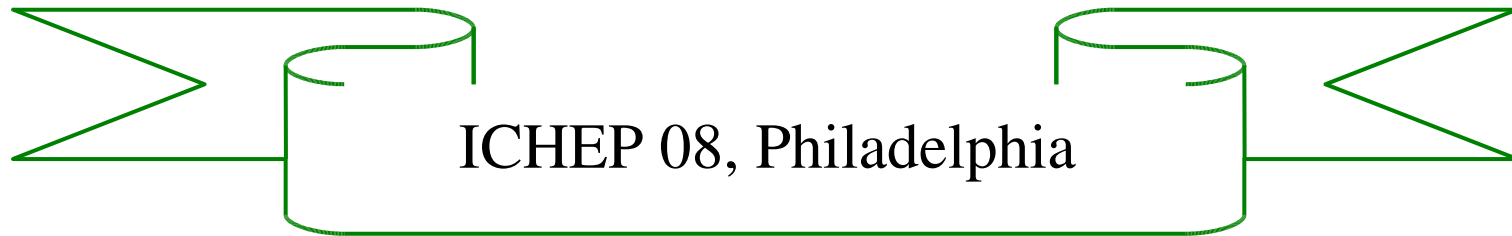




Searches for New Physics at CDF



ICHEP 08, Philadelphia

Max Goncharov
Texas A&M University



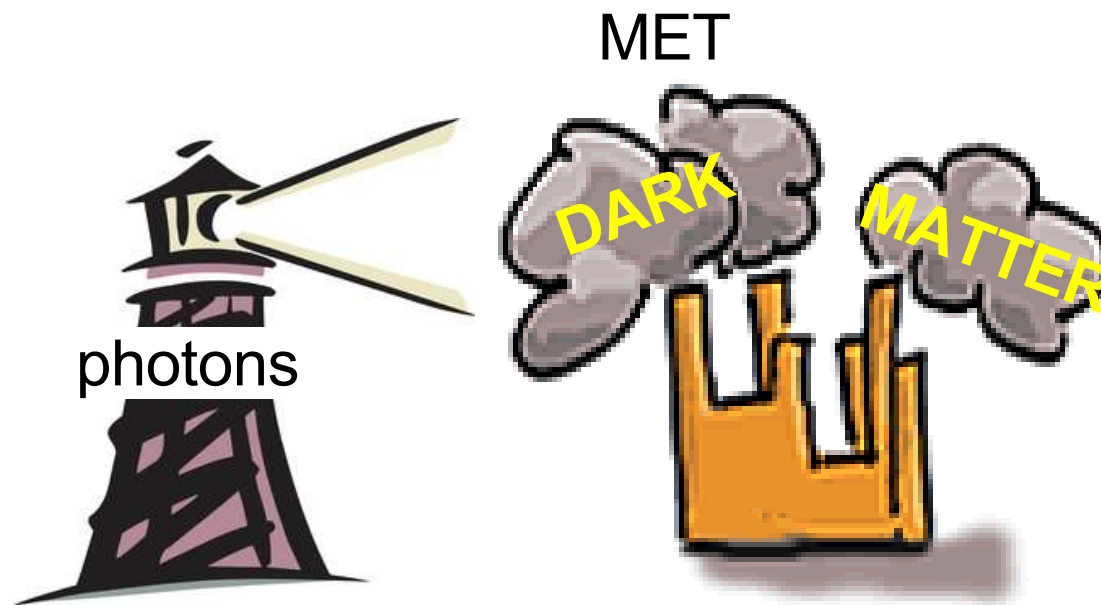
In This Talk

All results with 2 fb^{-1} of integrated luminosity

Signature based searches

Photons in the final states

MET in the final states

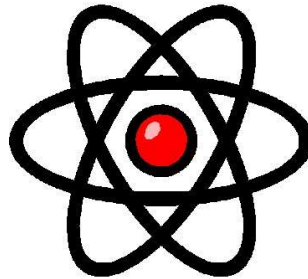




Extending the Reach

Each Analysis Has NEW:

technology



final state

hardware

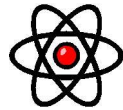
cross-section measurement



Extending the Reach

Each Analysis Has NEW:

technology



final state



hardware

cross-section measurement



Extending the Reach

Each Analysis Has NEW:

technology 

final state 

hardware



cross-section measurement



Extending the Reach

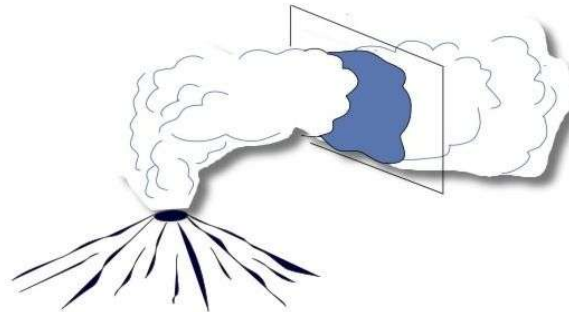
Each Analysis Has NEW:

technology 

final state 



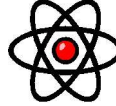






hardware 

cross-section





Outline

- jet + jet + MET 
- $\gamma + \gamma + \text{MET}$  
- $\gamma + \text{jets} + \text{MET}$  
- $\gamma + \text{b-jet} + \text{jet} + \text{MET}$  
- $\gamma + \text{b-jet} + \text{lepton} + \text{MET}$ 
- $\rightarrow \text{Top pair} + \gamma$ 



jet + jet + MET

2 Jets with $E_T > 30$ GeV

No 3rd Jet with $E_T > 15$ GeV

Scalar Jet $H_T > 225$ GeV

Event Missing $E_T > 100$ GeV

Background

$Z \rightarrow \nu\nu$

$W \rightarrow l\nu$

Top

QCD

Total

Data

Events

71 ± 12

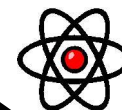
97 ± 10

11 ± 2

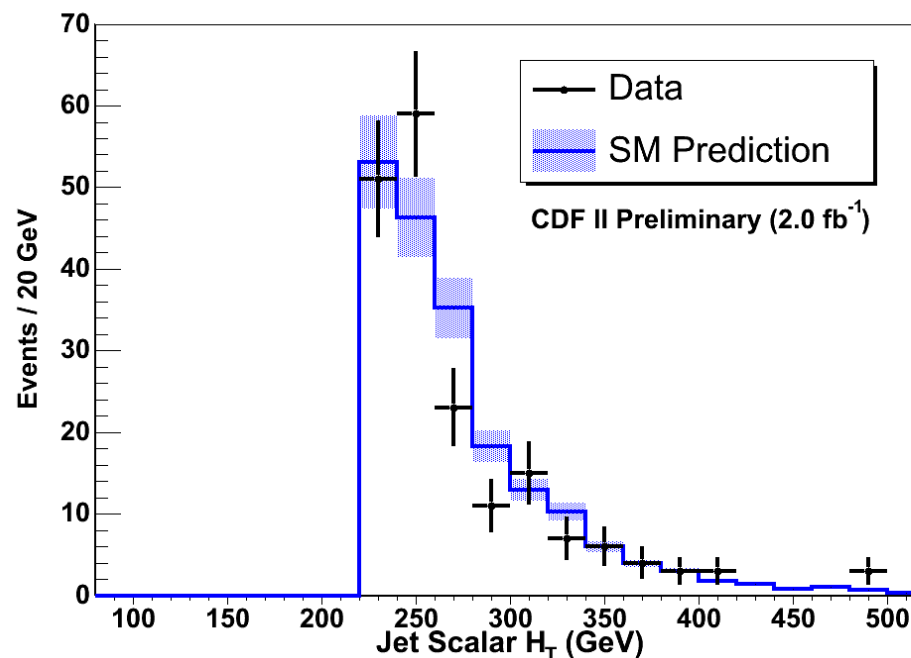
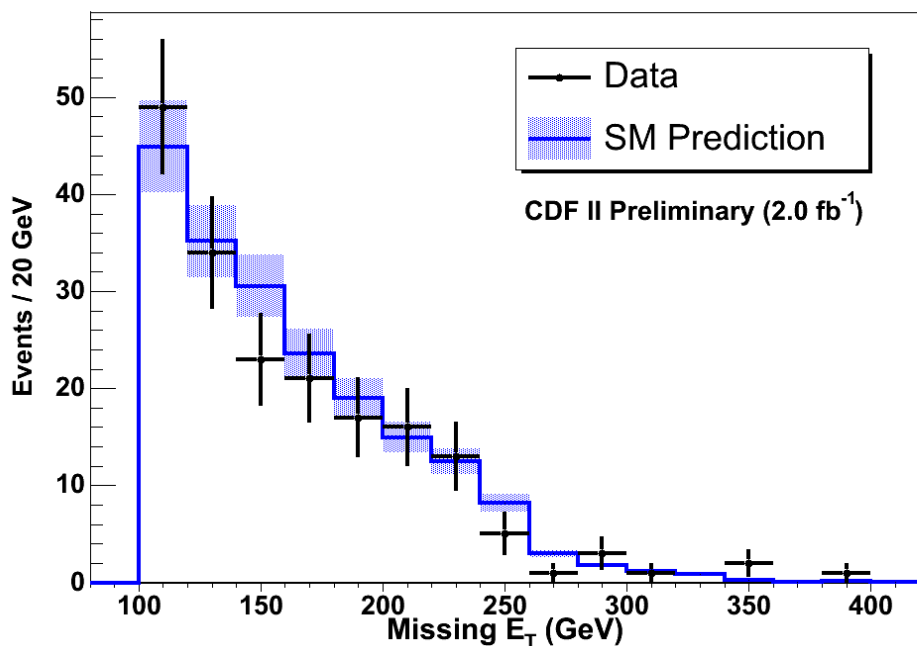
9 ± 9

196 ± 29

186



Data based



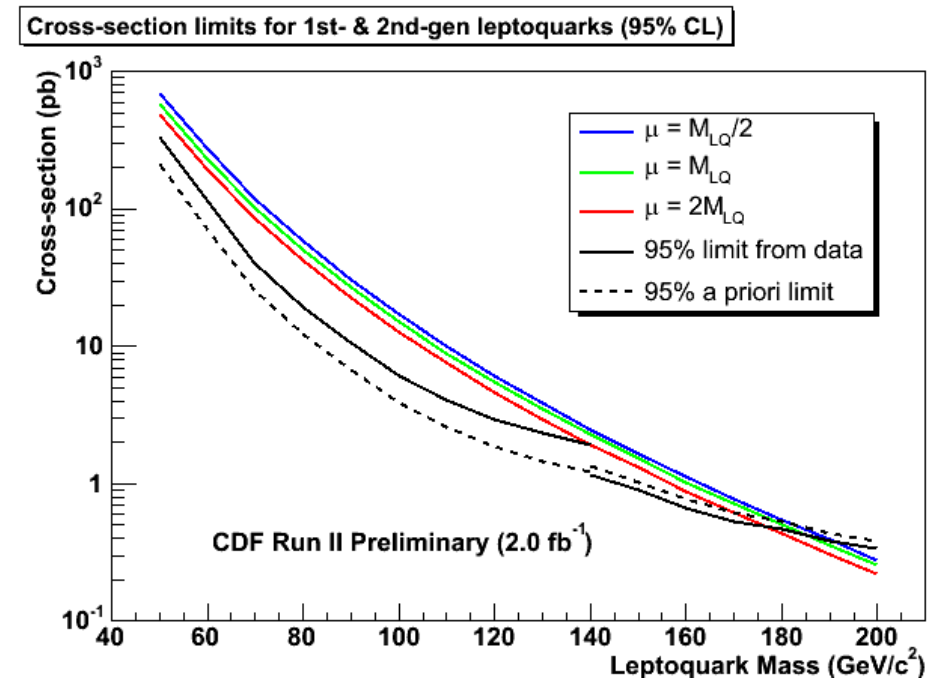
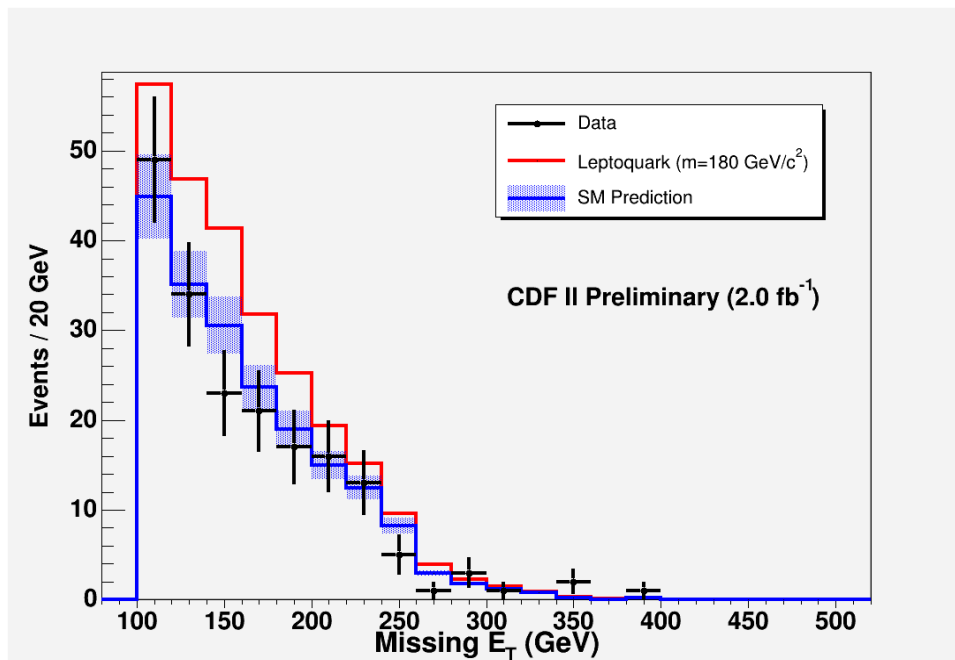


jet + jet + MET

Limits on Scalar Leptoquark Model:


Leptoquark Generation Lower Mass Limit (GeV/c^2)

1st or 2nd	177
3 rd	167







Outline

jet + jet + MET 

$\gamma + \gamma + \text{MET}$  

$\gamma + \text{jets} + \text{MET}$  

$\gamma + \text{b-jet} + \text{jet} + \text{MET}$  

$\gamma + \text{b-jet} + \text{lepton} + \text{MET}$  

→ Top pair + γ



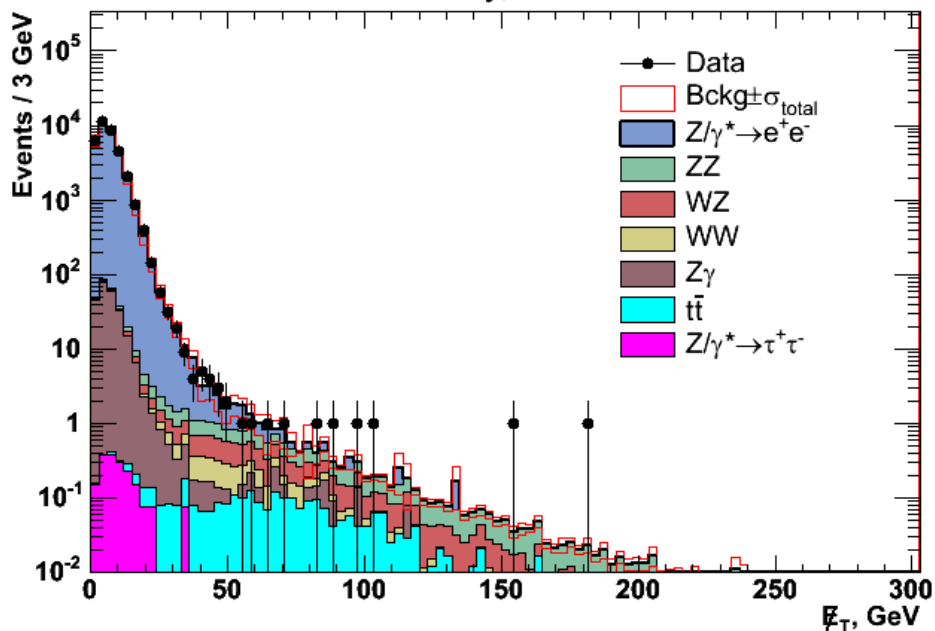
$\gamma + \gamma + \text{MET}$

2 Photons $E_T > 14 \text{ GeV}$

Photon $|\eta| < 1.1$

$86 \text{ GeV}/c^2 < M_Z < 97.5 \text{ GeV}/c^2$

CDF Run II Preliminary, 2.0 fb^{-1} : $Z \rightarrow e^+e^-$ events



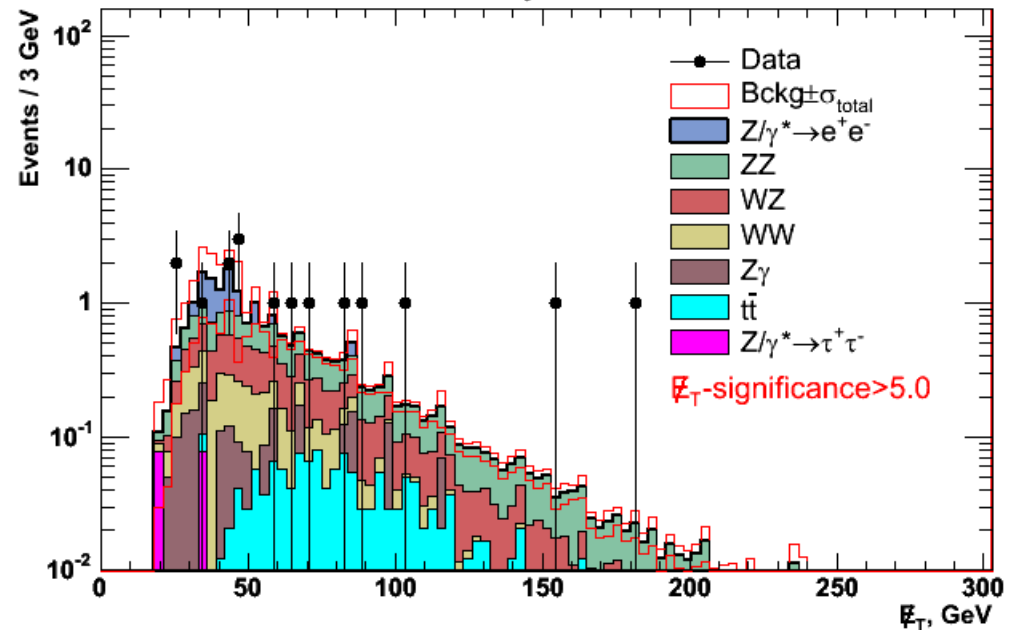
MET Model 

- separate fake and real MET
- each event \rightarrow MET p.d.f.

EMTiming 

- non-collision backgrounds
- pile-up backgrounds

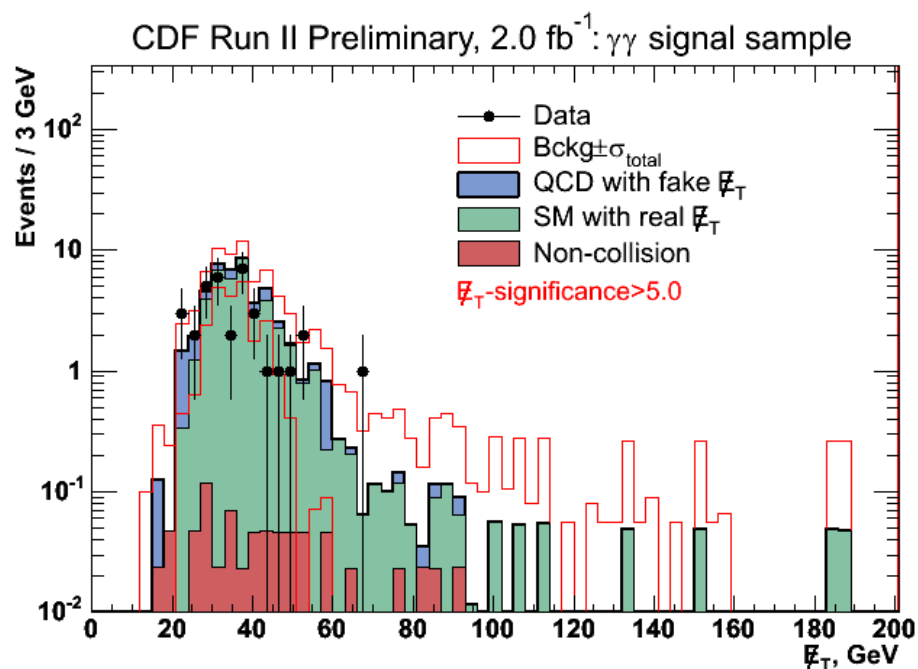
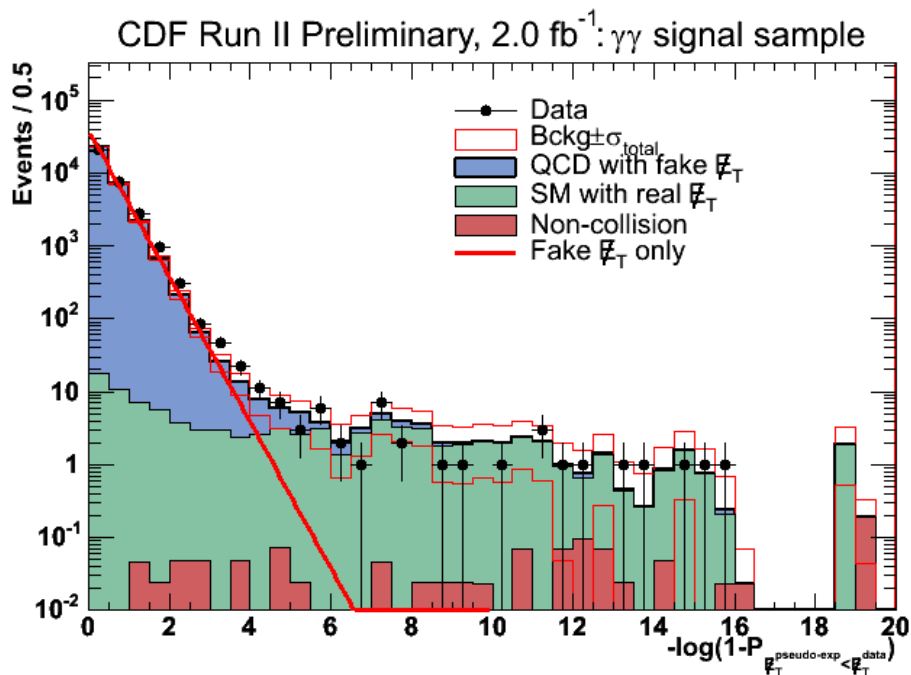
CDF Run II Preliminary, 2.0 fb^{-1} : $Z \rightarrow e^+e^-$ events





$\gamma + \gamma + \text{MET}$

	MET Sig. > 3	MET Sig. > 4	MET Sig. > 5
Observed	120	52	34
EWK	53.6 ± 8.9	47.3 ± 8.0	41.6 ± 7.0
Fake MET	52.1 ± 11.5	15.4 ± 3.8	6.2 ± 2.7
Non-Collision	0.9 ± 0.3	0.9 ± 0.3	0.8 ± 0.3
Total	106.6 ± 14.5	63.6 ± 8.9	48.6 ± 7.4







Outline

jet + jet + MET 

γ + γ + MET  

γ + jets + MET  

γ + b-jet + jet + MET  

γ + b-jet + lepton + MET 
→ Top pair + γ 



$\gamma + \text{Jets} + (\text{MET})$



Photon $E_T > 30 \text{ GeV}$, $|\eta| < 1.1$

Veto non-collision (EMTiming) backgrounds



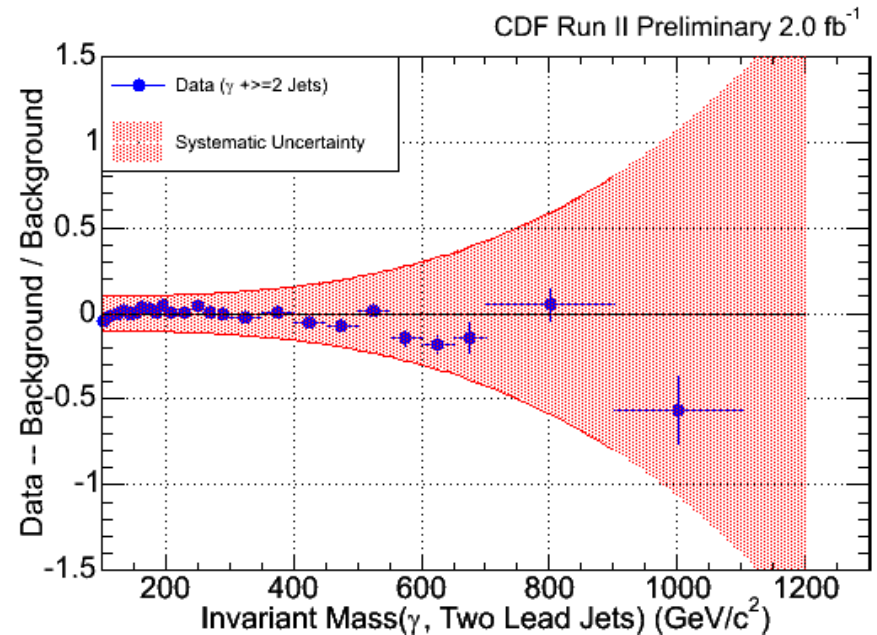
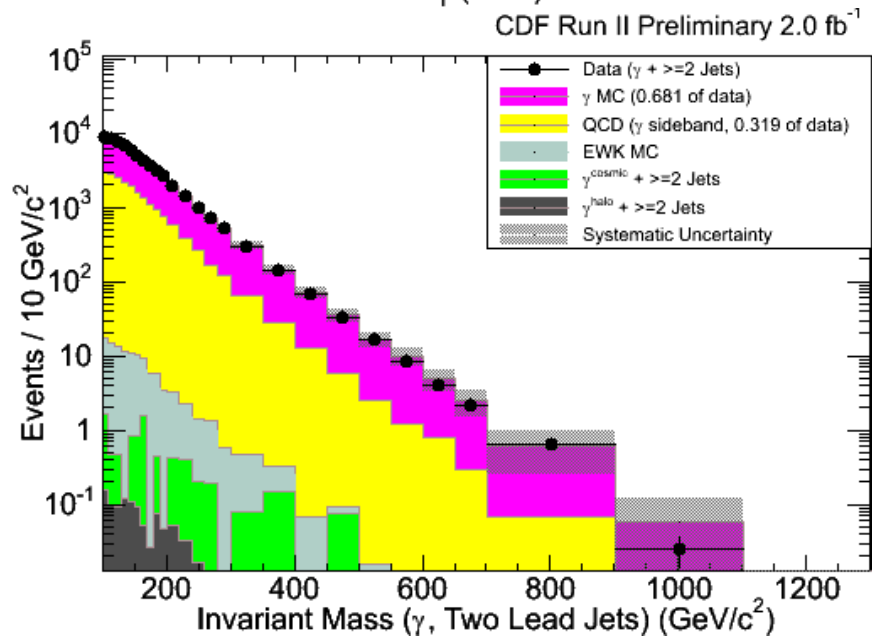
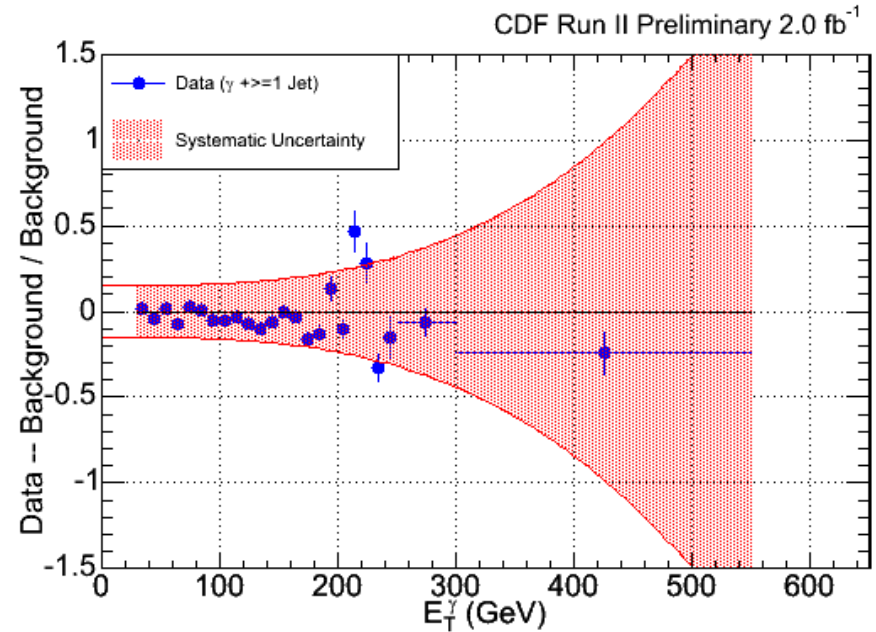
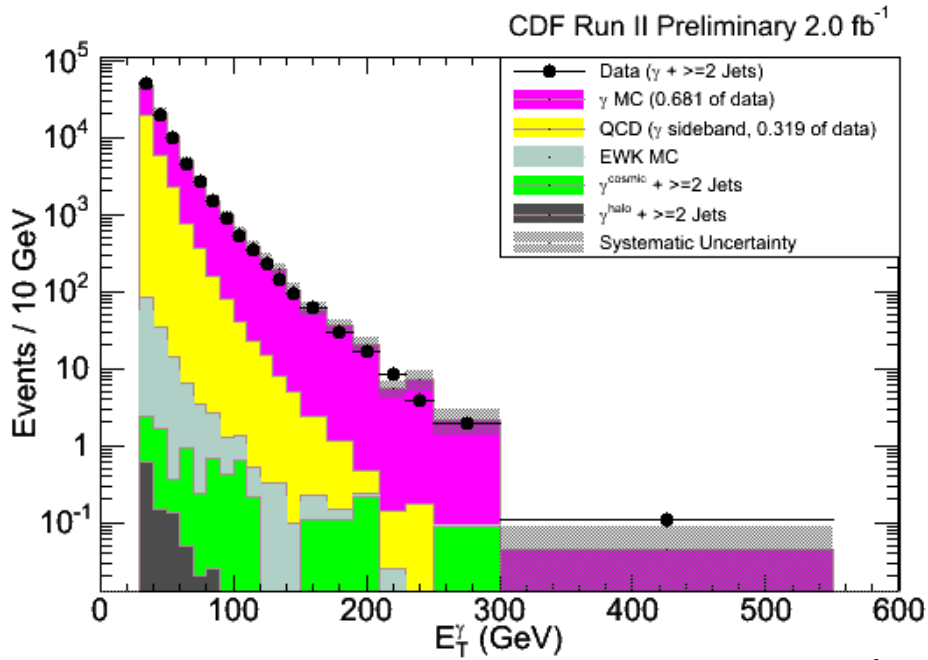
Veto leptons (by requiring no track)

≥ 1 Jet ($E_T > 15 \text{ GeV}$, $|\eta| < 3.0$)

	Photon + ≥ 1 Jet	Photon + ≥ 2 Jets
SM Photon (Photon MC)	2.6M	650k
QCD (Photon sideband)	1M	280k
EWK (EWK MC)	5.4k	1.3k
Cosmic (Data-based)	110	7
Beam Halo (Data-based)	9	<1

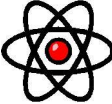


γ + Jets + (MET)





Outline

jet + jet + MET 

$\gamma + \gamma + \text{MET}$  

$\gamma + \text{jets} + \text{MET}$  

$\gamma + \text{b-jet} + \text{jet} + \text{MET}$  

$\gamma + \text{b-jet} + \text{lepton} + \text{MET}$ 

→ Top pair γ 



$\gamma + b\text{-jet} + \text{jet} + \text{MET}$



Predict jet fraction in photon candidates

Photon $E_T > 30 \text{ GeV}$, $|\eta| < 1.1$

Two jets with $E_T > 15 \text{ GeV}$

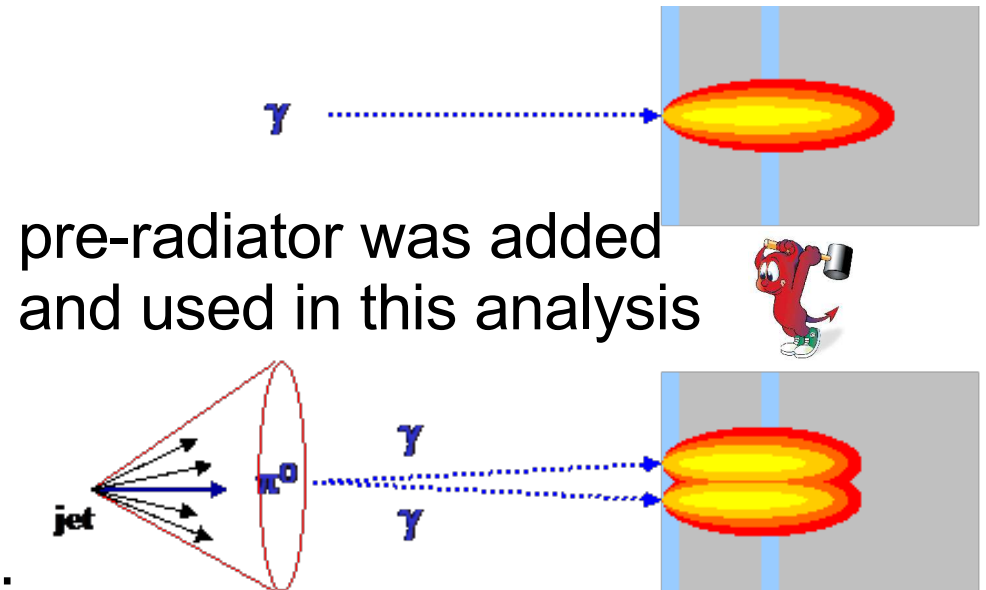
one jet b-tagged

$\text{MET} > 25 \text{ GeV}$

Background

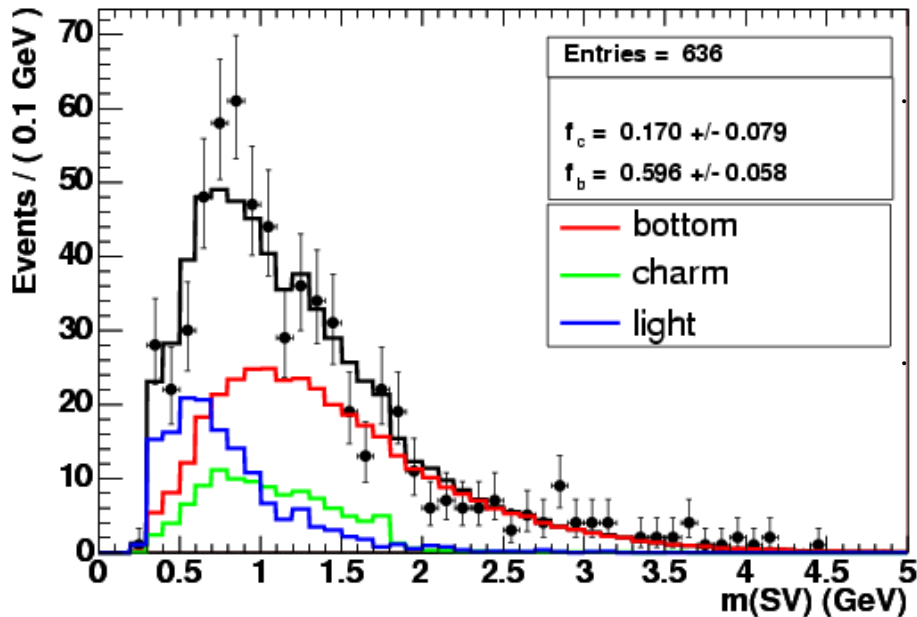
Prediction

γb	$291 \pm 7 \pm 50$
γc	$92 \pm 25 \pm 45$
Fake b, real γ	$141 \pm 6 \pm 30$
Fake γ	$113 \pm 49 \pm 54$
Total	$637 \pm 54 \pm 128$





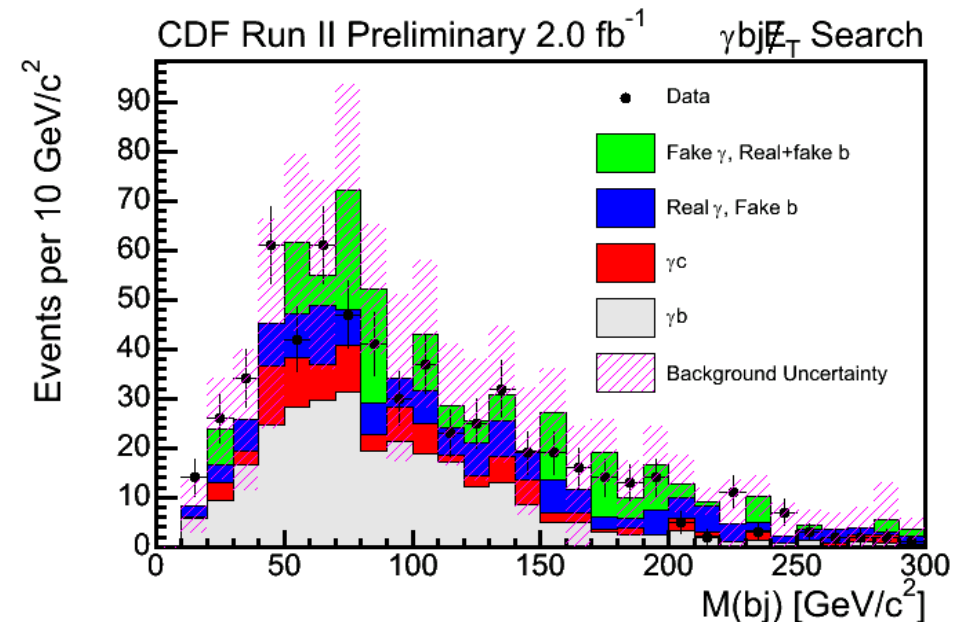
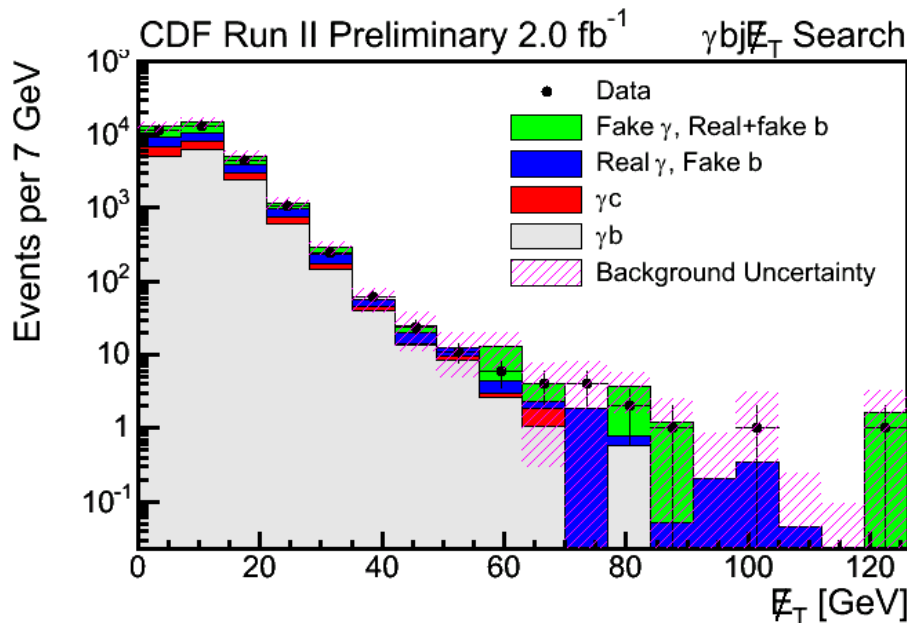
$\gamma + b\text{-jet} + \text{jet} + \text{MET}$



Photon + true heavy-flavor normalization from data

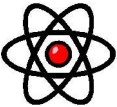
- Fit secondary vertex mass to templates 637 ± 139 (exp) vs. 617 (obs)

SV – secondary vertex





Outline

jet + jet + MET 

γ + γ + MET  

γ + jets + MET  

γ + b-jet + jet + MET  

γ + b-jet + lepton + MET 

→ Top pair + γ 



$\gamma + b\text{-jet} + \text{lepton} + \text{MET}$



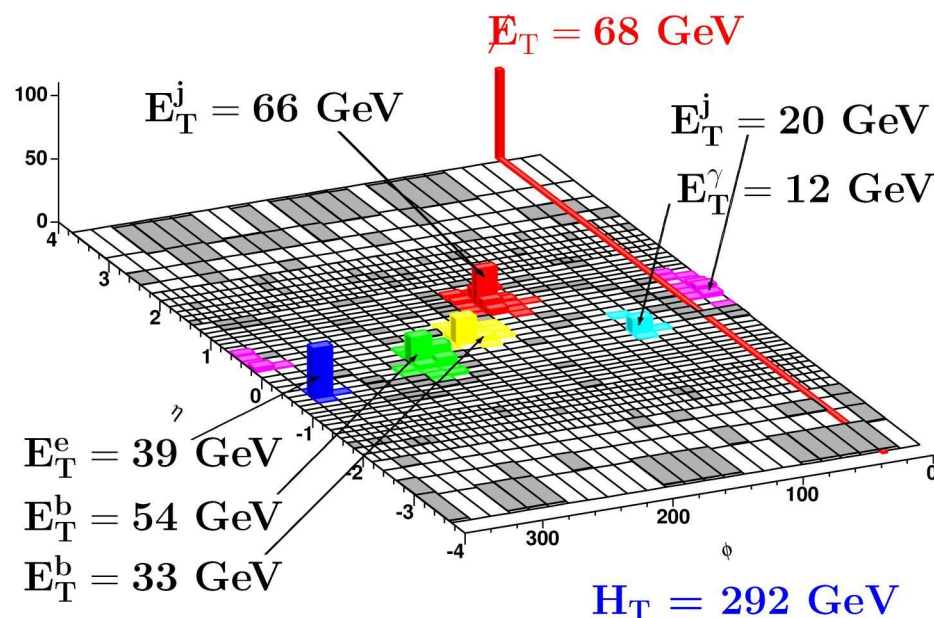
Extension of $\gamma + \text{lepton} + \text{MET}$

Photon $E_T > 10$ GeV

Lepton $E_T > 20$ GeV

Jet $E_T > 15$ GeV, b-tag

MET > 20 GeV

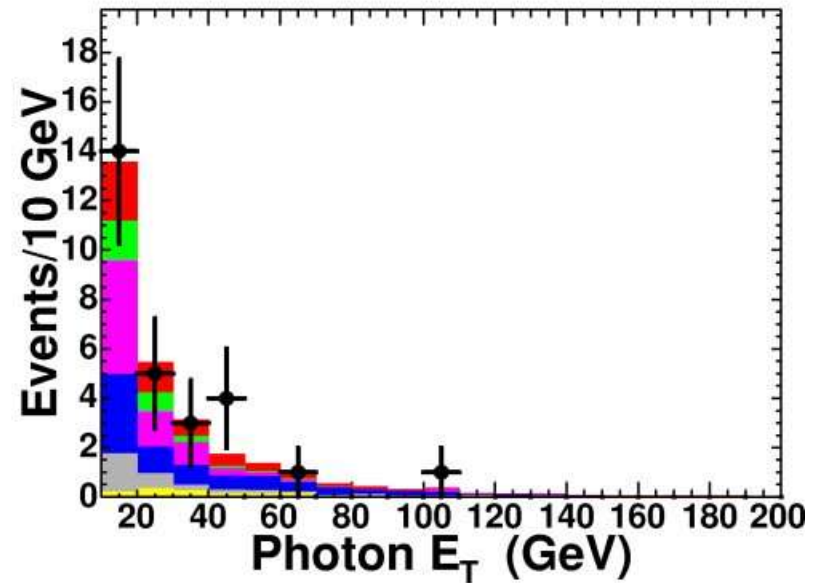
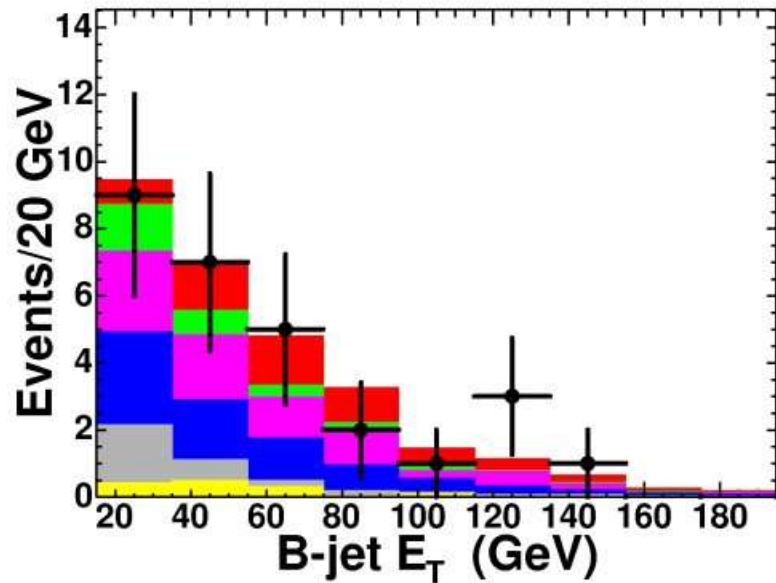
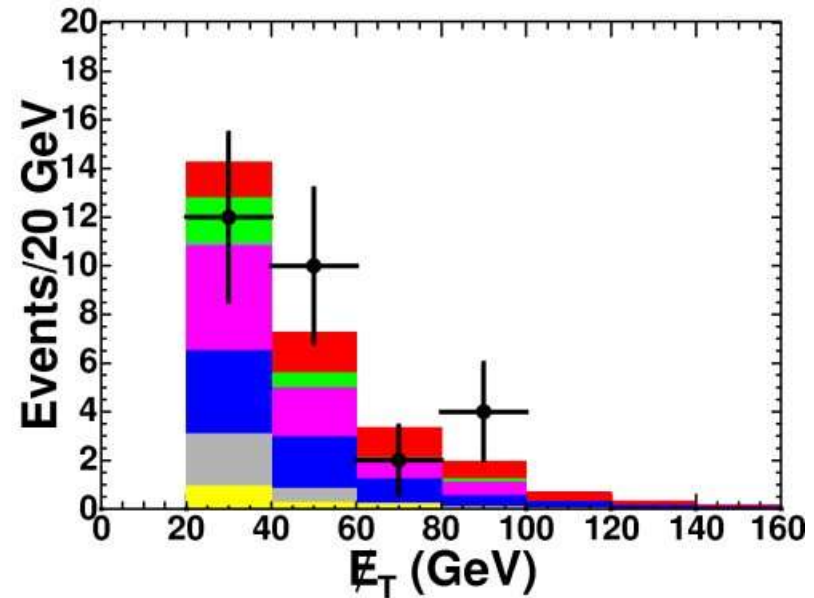
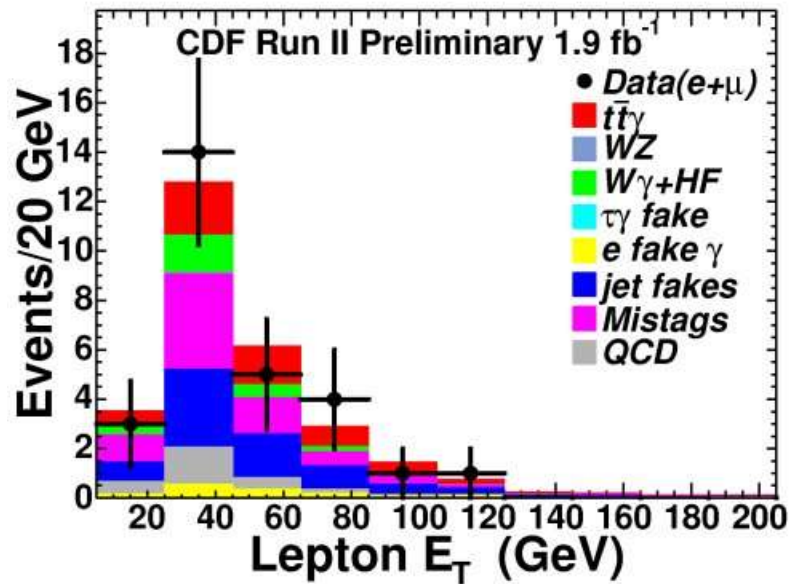


Run 193396 Event 1050006

	e	μ	e + μ
Predicted	16.6 ± 2.2	11.2 ± 1.7	27.9 ± 3.6
Observed	16	12	28

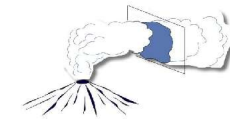


γ + b-jet + lepton + MET





Top Pair + γ



Also ask for:

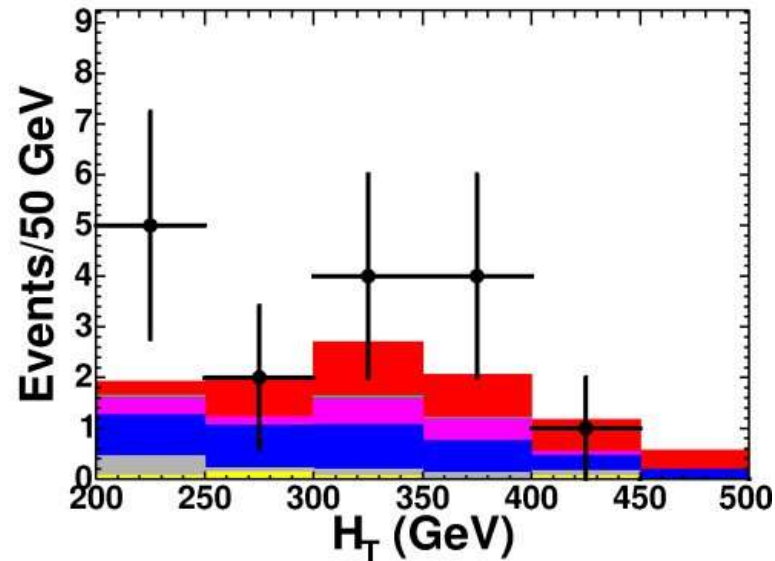
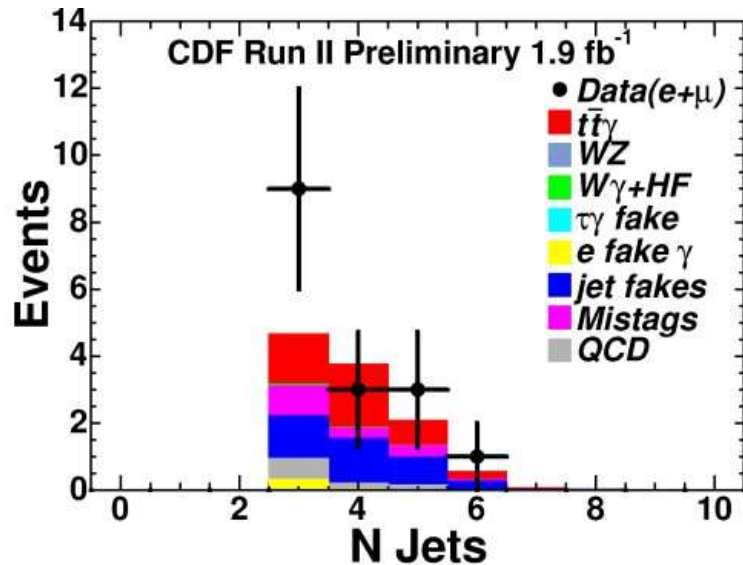
> 2 jets

$H_T > 200$ GeV

Control sample for $tt+H$ (LHC), Q (top)

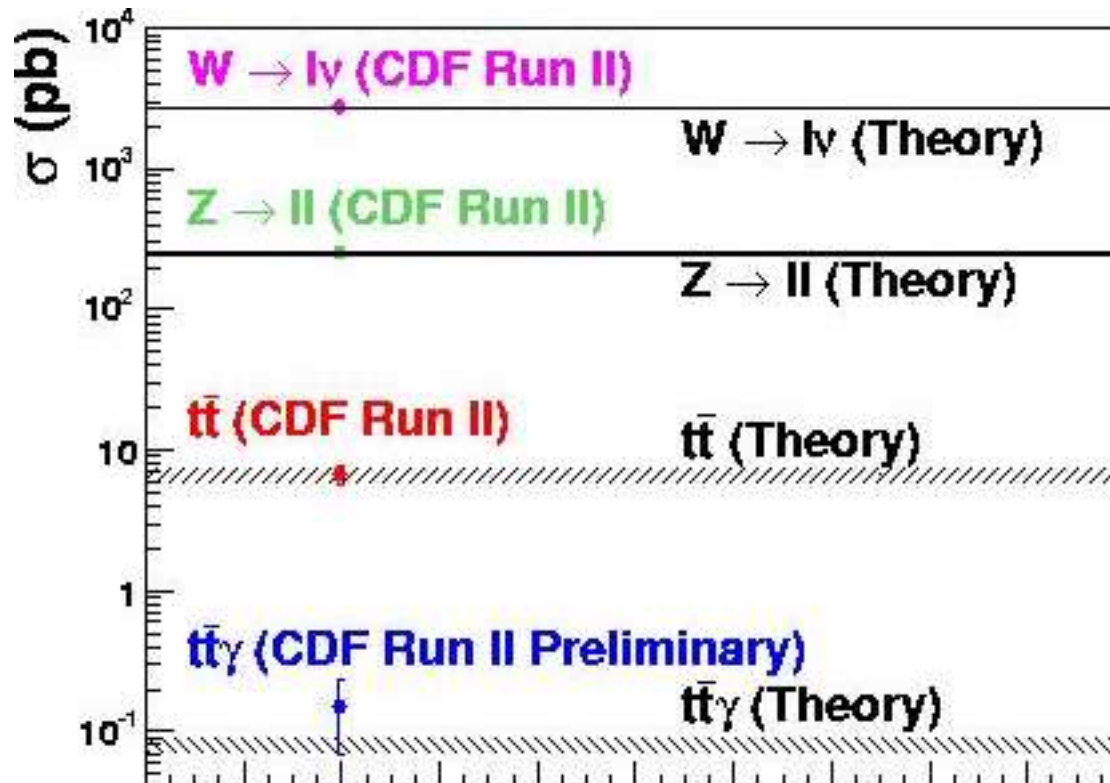
	e	μ	e + μ
Predicted	6.7 ± 1.4	4.4 ± 1.3	11.1 ± 2.3
Observed	8	8	16

Observation at 2.3σ





Top Pair + γ





Conclusion

Several New Signatures

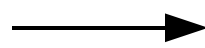


Standard Model Holds



jet + jet + MET

$\gamma + \gamma + \text{MET}$



plan to use MET model for Higgs searches

$\gamma + \text{jets} + \text{MET}$

$\gamma + \text{b-jet} + \text{jet} + \text{MET}$

$\gamma + \text{b-jet} + \text{lepton} + \text{MET}$

→ Top pair + γ



plan to observe at 5σ