

Searches for New Physics at CDF

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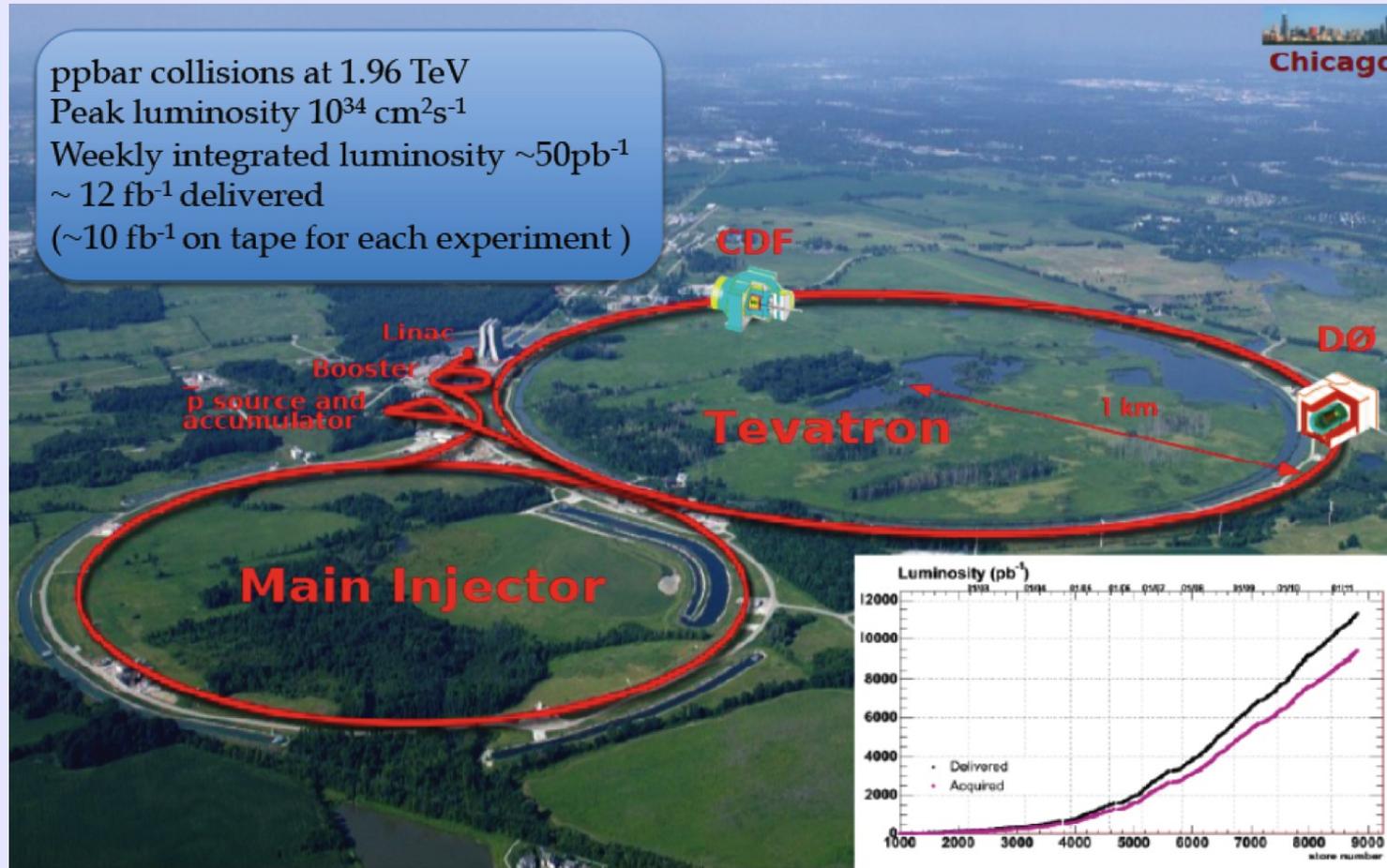
Outline

- Introduction
- Search for dark matter in the monojet + MET final state
- Search for dark matter in the mono-top + MET final state
- Search for long-lived heavy neutral particles in the exclusive γ +MET final state
- Summary

Searches for New Physics

- Standard Model isn't a complete theory
- Cosmological evidence shows that most of the universe isn't composed of matter described by the Standard Model
- Radiative corrections to the Higgs mass need to be canceled at some higher scale
- Endgame for a long history of searches at CDF

Tevatron

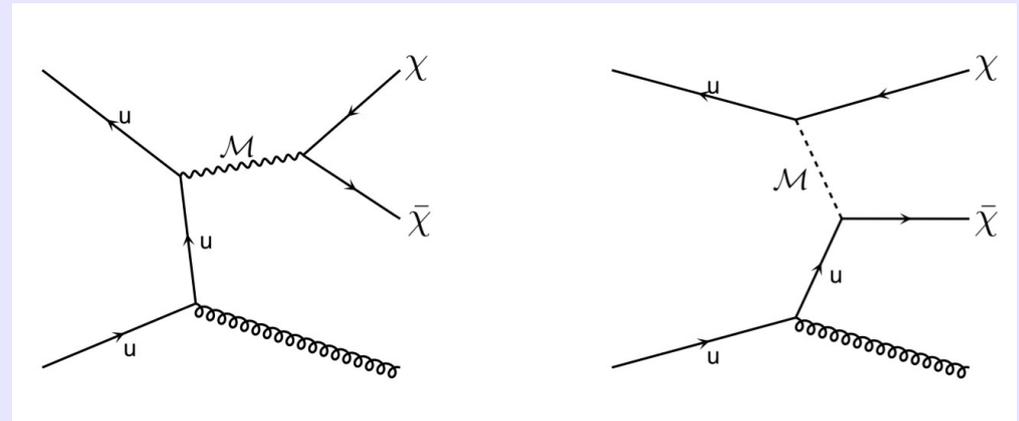


Monojets

Dark matter is about $\sim 25\%$ of the universe, but we don't know its identity

Direct detection: look for recoil from dark matter scattering off of nuclei – limited reach for small masses

Collider experiments: look for annihilation into dark matter pairs tagged by initial state radiation



Search is fairly model independent with two regimes: effective theory with very heavy mediator or a kinematically accessible mediator

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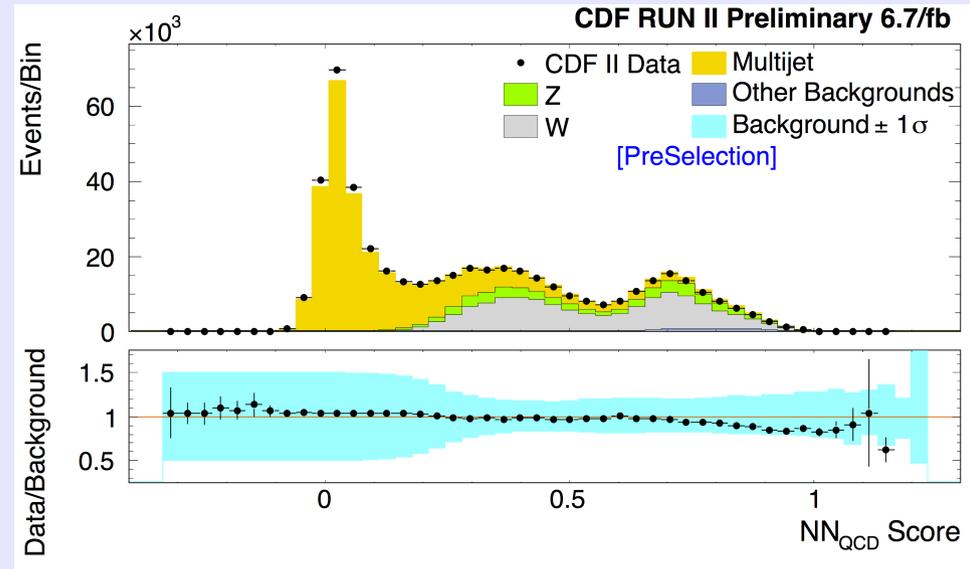
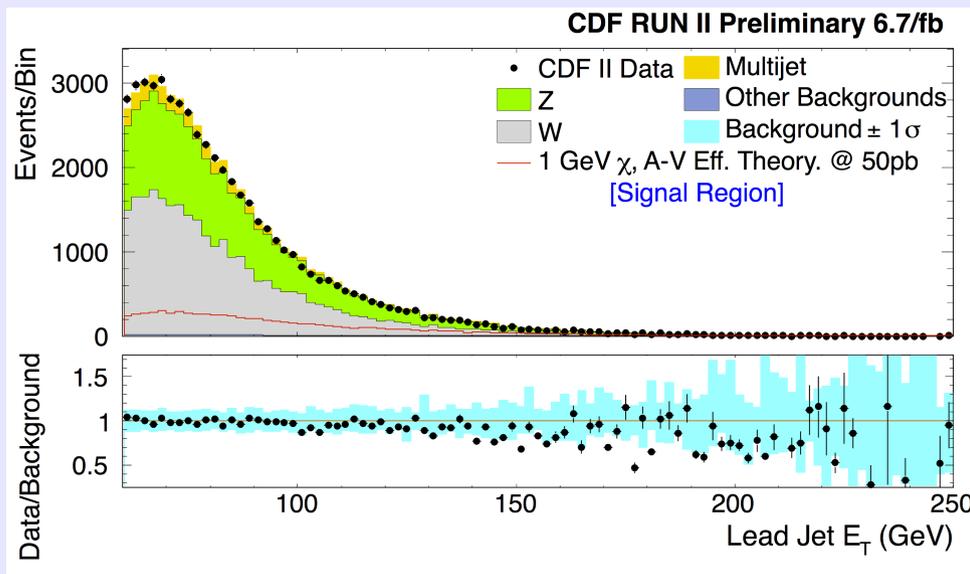
Monojets: Results

Jet with $E_T > 60$ GeV, $|\eta| < 1.1$

MET > 60 GeV

Extra jets with $E_T < 30$ GeV, $|\eta| < 2.4$

Reject QCD with a neural network

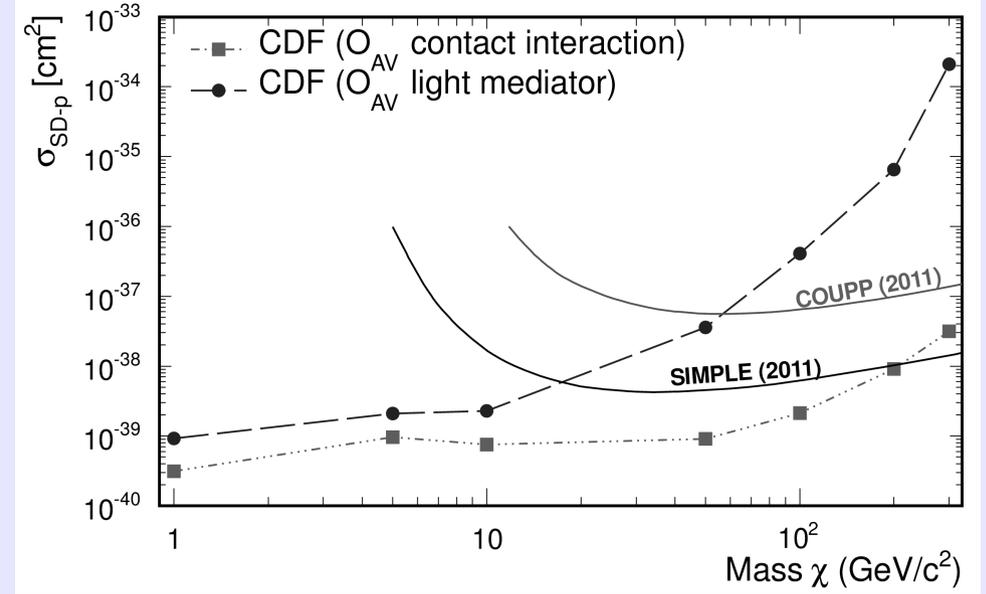
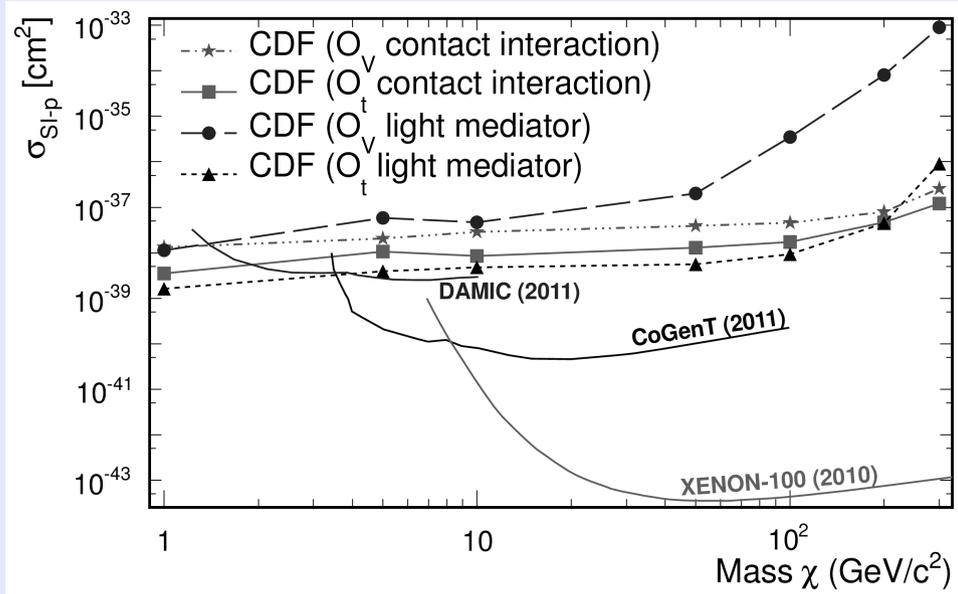


Model all backgrounds except QCD with Monte Carlo

Model QCD with a data-derived multi-jet probability normalized to NN score region (0.2,0.3)

Shape analysis of jet E_T : No excess found \rightarrow set limits

Monojets: Limits



CDF outperforms direct detection at low dark matter masses and in scenarios with spin dependent interactions; however, CMS has since produced more sensitive limits

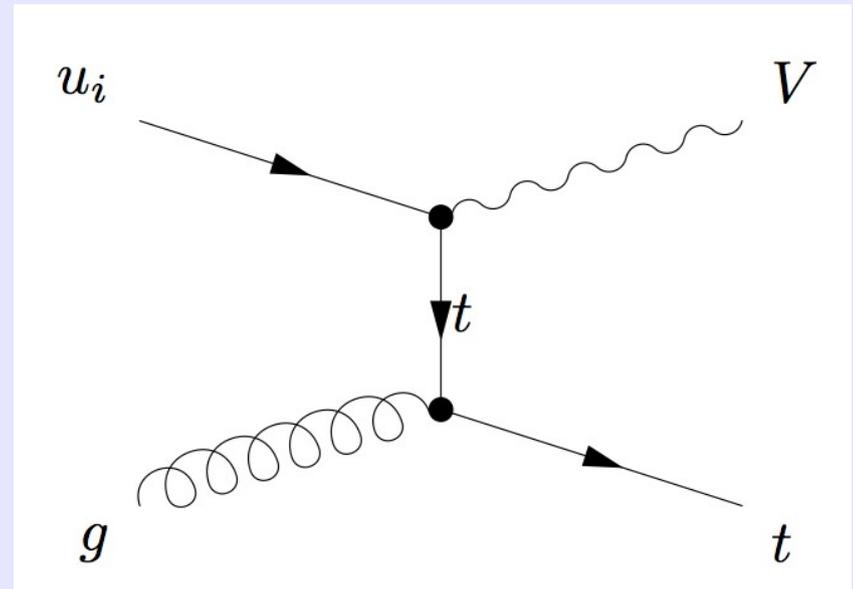
Monotop

Dark matter produced in association top quarks yields a unique signature

- Also sensitive to
 - Flavor changing neutral currents
 - SUSY: $\tilde{q} \rightarrow \tilde{\chi}_1^0 + t$
 - Vector leptoquark $\rightarrow \nu + t$

Theory in: arXiv:1106.6199

Consider case with flavor changing interaction producing a neutral vector boson



Standard Model top + MET production is heavily suppressed

Published in Phys. Rev. Lett. 108, 201802 (2012)

Monotop

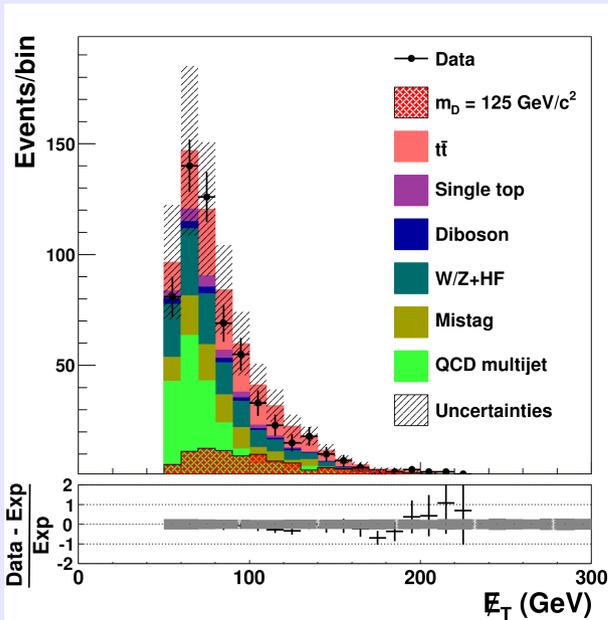
Signal Region

Require 3 jets (exactly one b-tagged) with:
 $E_T^1 > 35$ GeV, $E_T^2 > 25$ GeV, $E_T^3 > 15$ GeV

MET > 50 GeV

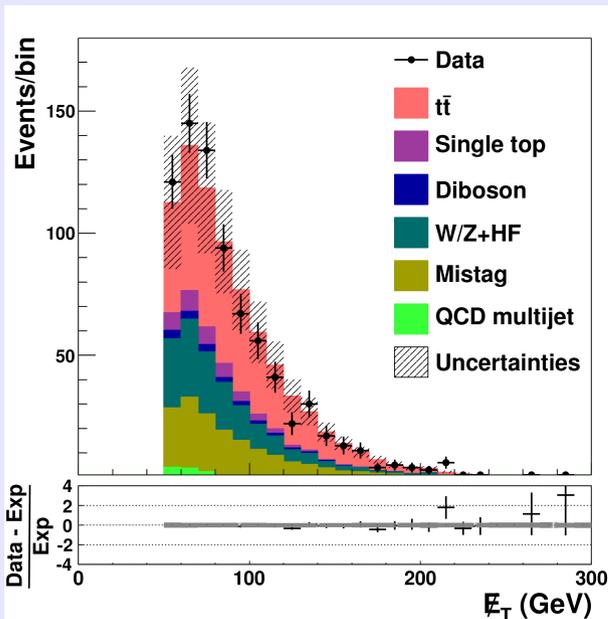
M_{jjj} consistent with top mass

No high-pt lepton



Control Region

Same as above
+ high-pt lepton

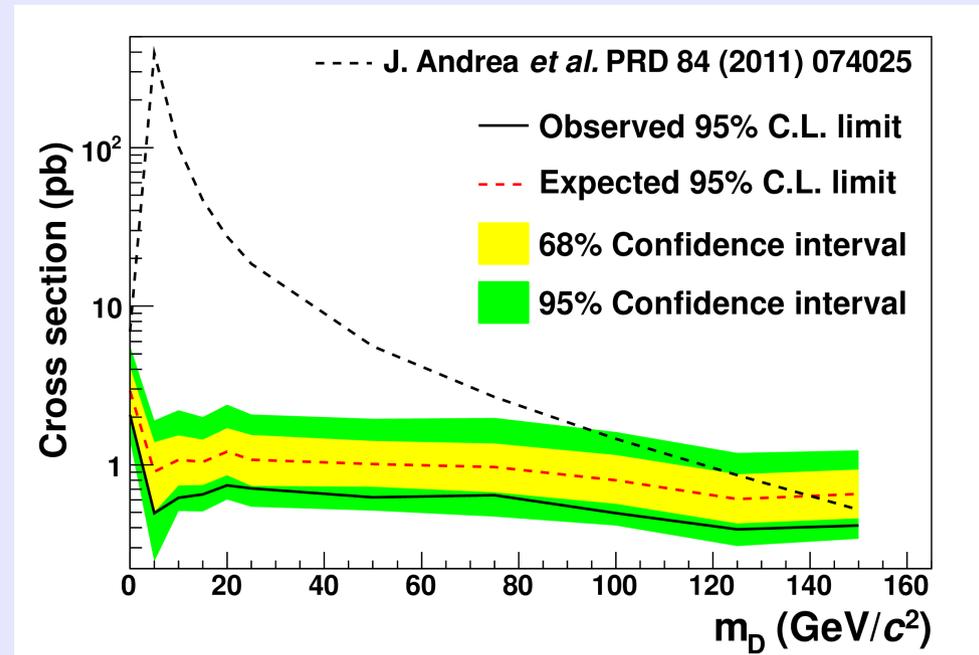


All backgrounds modeled with Monte Carlo except
QCD multijet → modeled with data-derived rate
matrix

Look for signal in the shape of the MET distribution
→ nothing found, set limits

Monotop : Result

- Exclude a monotop model up to a dark matter mass of 150 GeV/c^2
- Only the largest cross-section model
 - Many scenarios worth investigating at the LHC



Delayed Photons

Neutralinos with nanosecond scale lifetimes are common in GMSB models

In certain models, only neutralino and gravitino are accessible at the Tevatron

Look for:

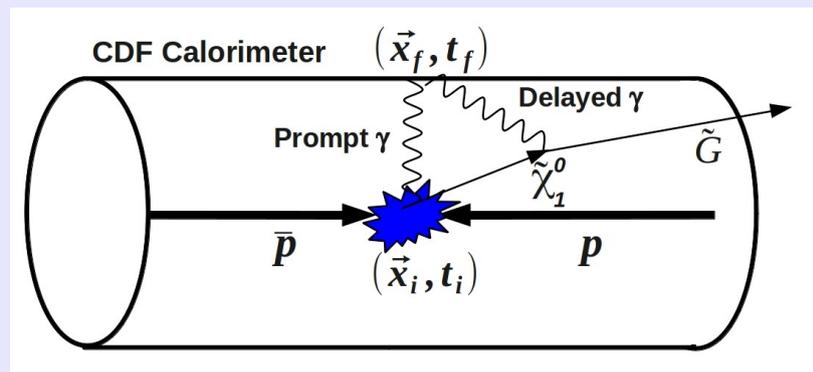
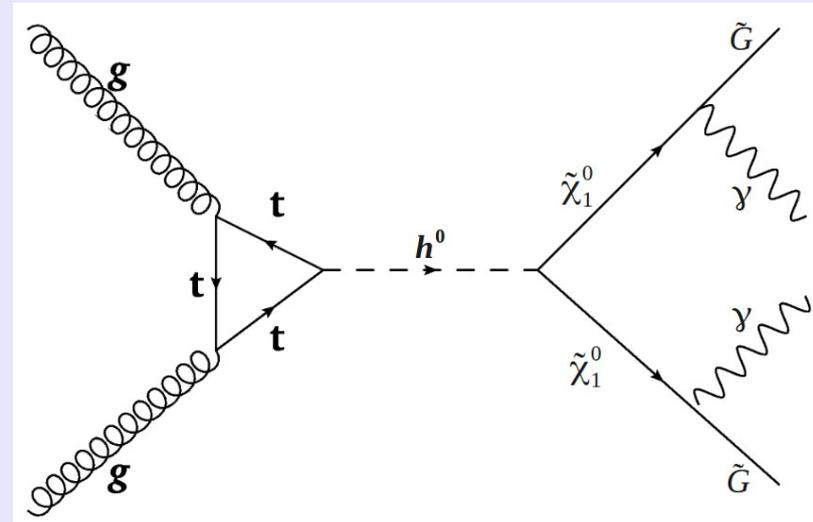
A photon with $E_T > 45$ GeV

MET > 45 GeV

No other clusters ($E_T > 15$ GeV) or high-

p_T tracks ($P_T > 10$ GeV)

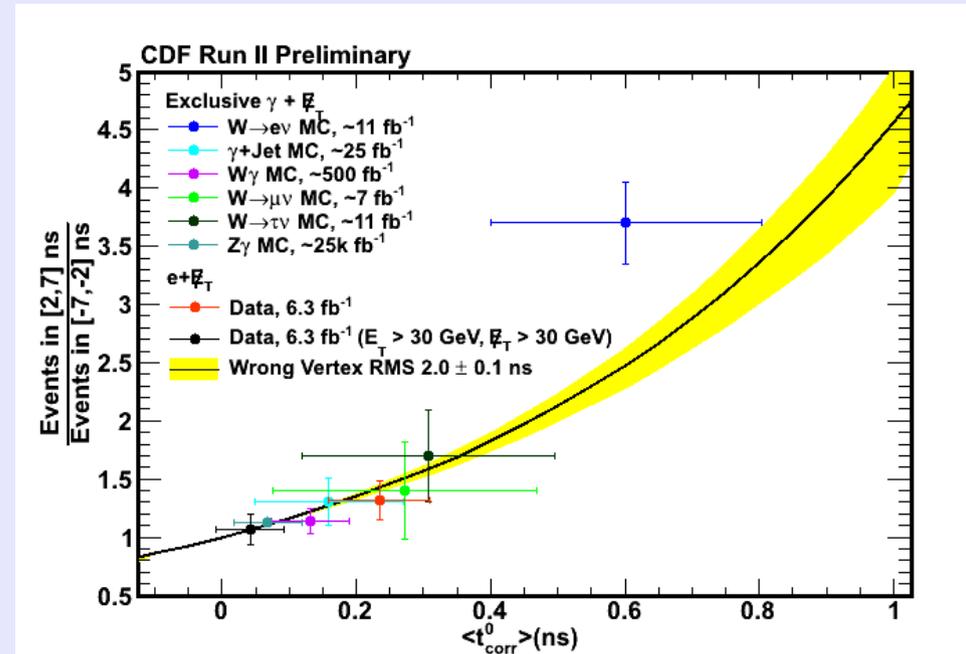
New analysis – started as an investigation of a large, preliminary excess: more in CDF public note 10788



See phenomenology paper:
J. Mason & D. Toback
Phys. Lett. B702 (2011)

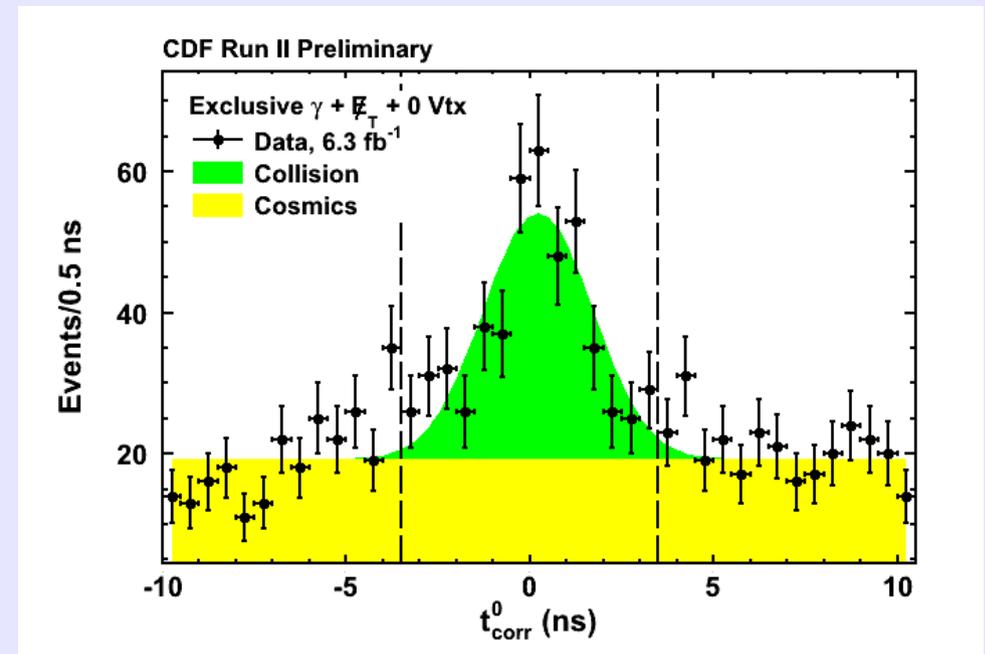
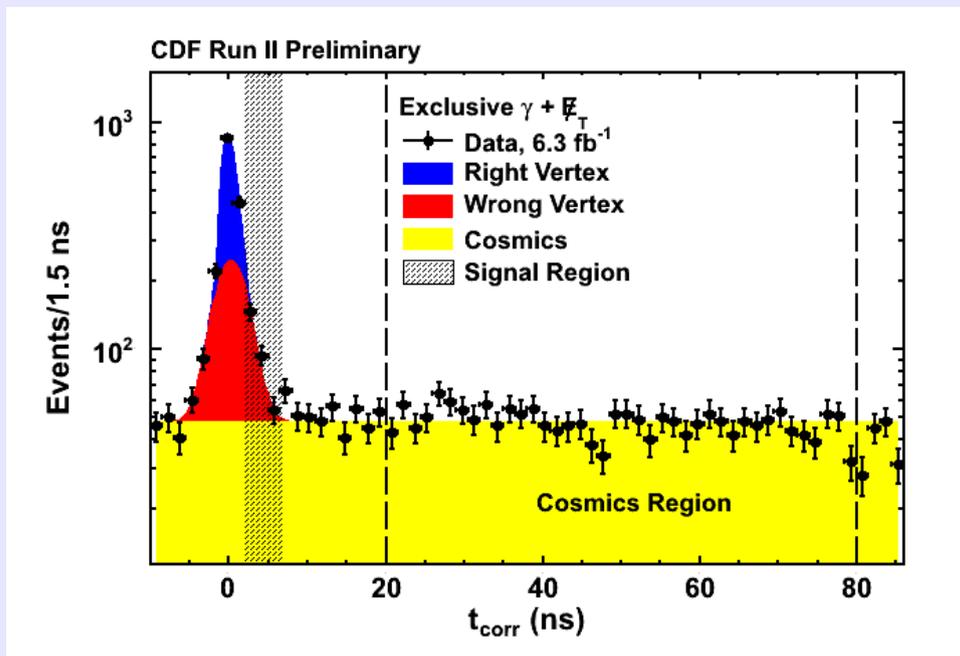
Delayed Photons : Wrong Vertices

- Look for excess of photons with timing in (2,7) ns
- Events where we choose the wrong vertex are the most difficult background
- Can estimate the wrong vertex rate if we know the distribution's mean
- Sample of events with no vertex reconstructed provides a method to estimate the mean of the wrong-vertex distribution



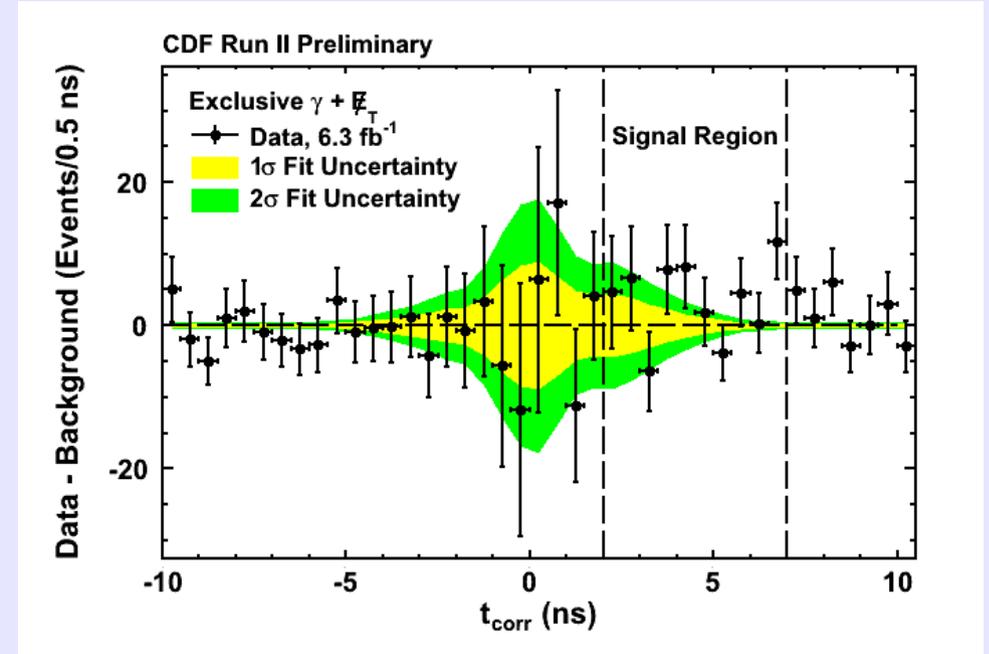
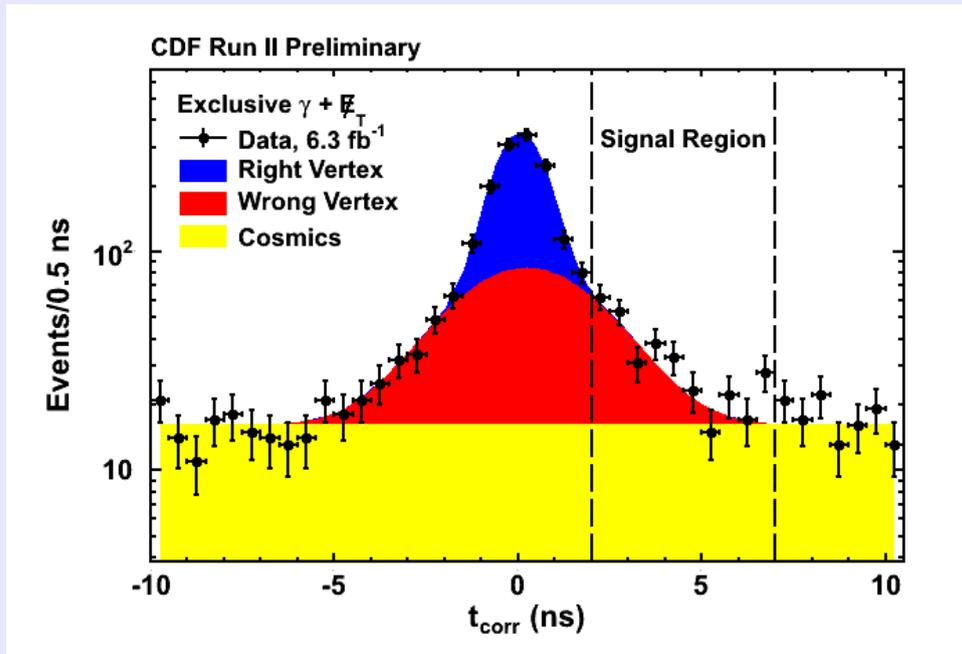
Delayed Photons : Background Estimation

Simultaneously fit the good-vertex sample and no-vertex sample in sideband regions.



Delayed Photons : Result

We find a modest excess in the signal region with 1.2σ significance.



This is a model independent result \rightarrow Plan on extending to full dataset and optimizing for GMSB production via h^0 .

Unclear how to directly bring to the LHC, but worth looking into further

Summary

- Final stretch for the new physics program at CDF
- Search for dark matter in the monojet channel
 - Excluded low mass dark matter
- Search for dark matter in the monotop channel
 - Excluded the highest cross-section scenario
 - First version – worth investigating at LHC
- Search for delayed photons in the exclusive photon + MET final state
 - No significant deviation from predictions
 - Considering incorporating full dataset and optimizing
 - Looking into bringing to LHC