Collaboration Meeting

Setting Limits on GMSB Models in the $\gamma\gamma + \not{E}_T$ final state with 2 fb^{-1}

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Outline

- Analysis Introduction
- Data Sets and Background Sources
- GMSB MC Simulation
- Optimization and Setting Limits
- Conclusion and Plan

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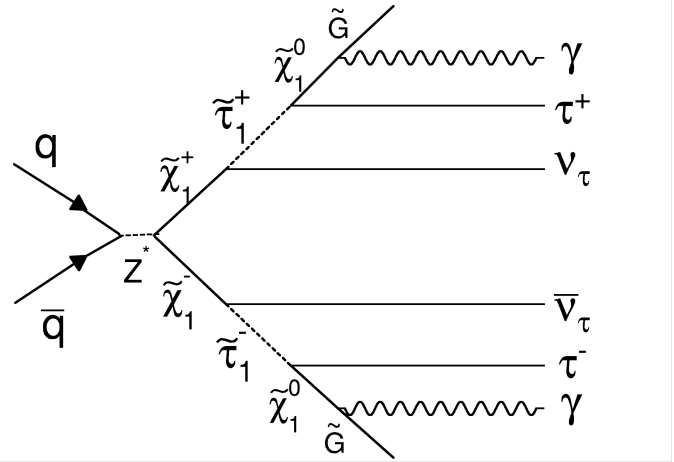
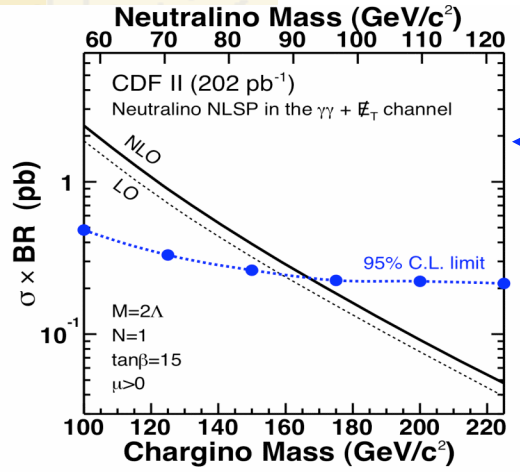
Dominant Signal Process



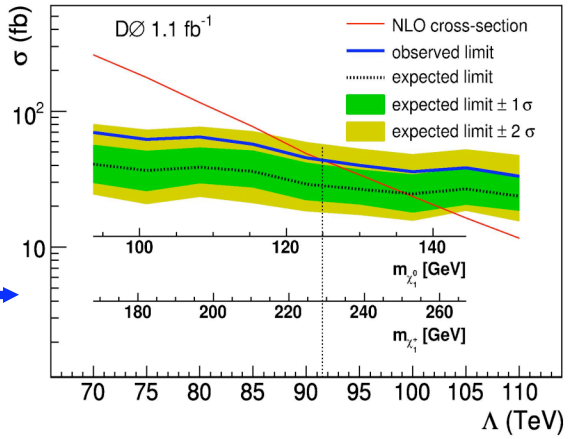
- Looking for $\tilde{\chi}_1^0 \rightarrow \gamma + \tilde{G}$
- Both neutralinos decay in the detector ⇒ Two photons
- $\gamma\gamma + \not{E}_T$: Optimal for low lifetimes (τ=0 and 1 ns)

D.Toback and P.Wagner, Phys.Rev.D70, 114032 (2004)

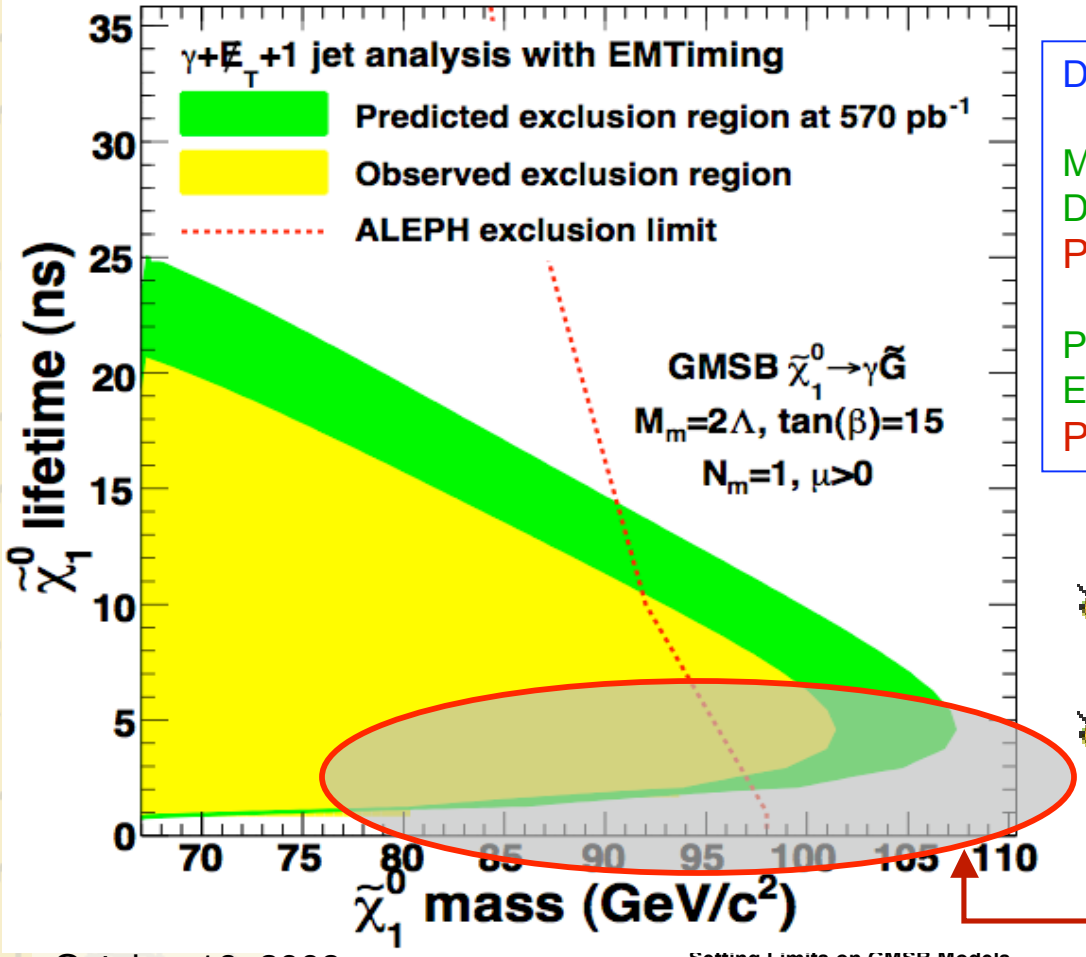


Previous Search at CDF (202 pb^{-1})
Phys.Rev.D71, 031104 (2005)

Recent Search at DØ (1.1 fb^{-1})
Phys.Lett.B659, 856 (2008)



Exclusion Region from the Delayed Photon Search



Delayed Photon Analysis

M.Goncharov, V.Krutelyov, E.Lee, D.Toback and P.Wagner
Phys. Rev. Lett 99, 121801 (2007)

P. Geffert, M.Goncharov, V.Krutelyov, E.Lee, D.Toback and P.Wagner
Phys. Rev. D 78, 032015 (2008)

- Single Delayed Photon : Not sensitive to low lifetimes
- Trying to understand our sensitivity here and for larger masses

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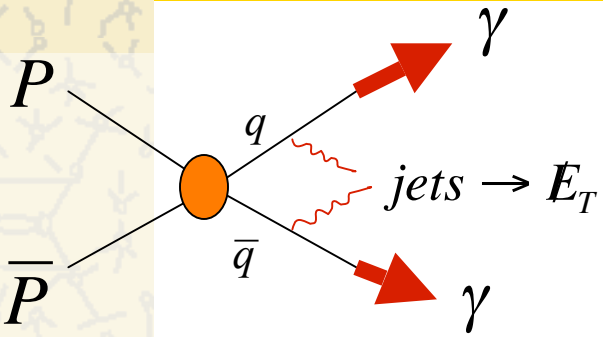
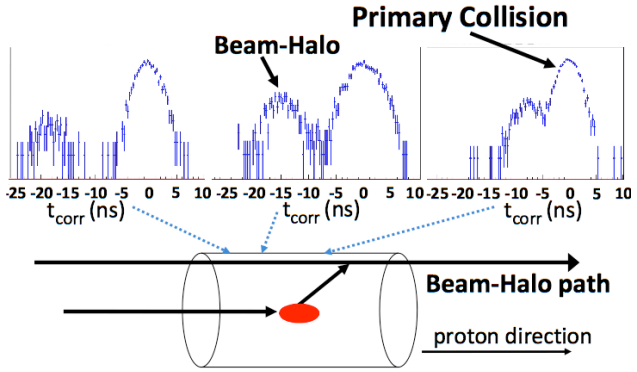
Background Sources and Data Sets



Collision (SM) Background



Non-Collision Background : Cosmic and Beam Halo

- Luminosity = 2 fb^{-1}
- Triggers : DIPHOTON_12 (iso), DIPHOTON_18 (no iso)
- Central Photon of $E_T > 13$ GeV
- Standard Photon ID cuts and Phoenix rejection cut
- Event Quality Cuts: $N_{vx12} \geq 1$, Highest ΣP_T Vertex, $|Z_{vx}| < 60$ cm
- Cosmics and Beam Halo removal cuts
- Use W→eν to study EWK backgrounds with real $\not{E}_T$
- Use Z→e$^+$e$^-$ to study QCD backgrounds with fake $\not{E}_T$

GMSB MC Simulation

- Use Pythia to generate the GMSB signal and cdfSim(Gen6) to simulate the detector.
- The EMTiming system is simulated. (CDF note 7982)

  http://hepr8.physics.tamu.edu/elee/EmtimeSimul.html
- Generate Neutralino MC samples with the following parameters fixed on the minimal GMSB Snowmass Slope SPS 8 with a neutralino NLSP

$$N = 1,\ \frac{M_m}{\Lambda} = 2,\ \tan\beta = 15,\ \mu > 0$$

- Assuming 18% acceptance error for now - Phys.Rev.D71, 031104 (2005).
- Generate different mass (70 GeV - 150 GeV) and lifetime (0 ns - 2 ns) points.

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Optimization Strategy and Expected Limits

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- For each GMSB parameter point find the optimal cuts by calculating the lowest 95% C.L. expected cross section limit.
- We use the standard cross section limit calculator taking into account the expected no. of background events, acceptance, luminosity and their errors.
- The result is a function of the optimization variable cuts.
  - MetSig : get rid of QCD with fake Met
  - H_T : get cascade decays from heavy particles
  - $\Delta\phi(\gamma_1,\gamma_2)$: get rid of back-to-back photons and Wrong Vertex
- Map it out as a function of neutralino mass and lifetime.

Optimization Results

H_t > 200 GeV
$\Delta\phi(\gamma_1,\gamma_2) < \pi - 0.15$ rad
MetSig > 3

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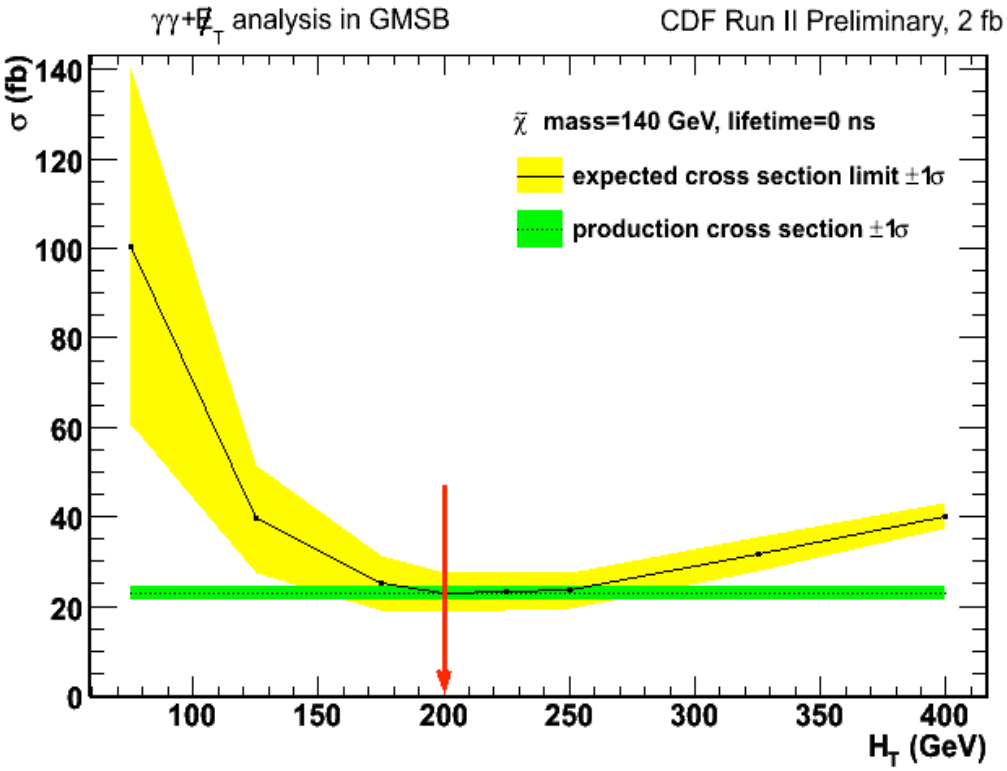
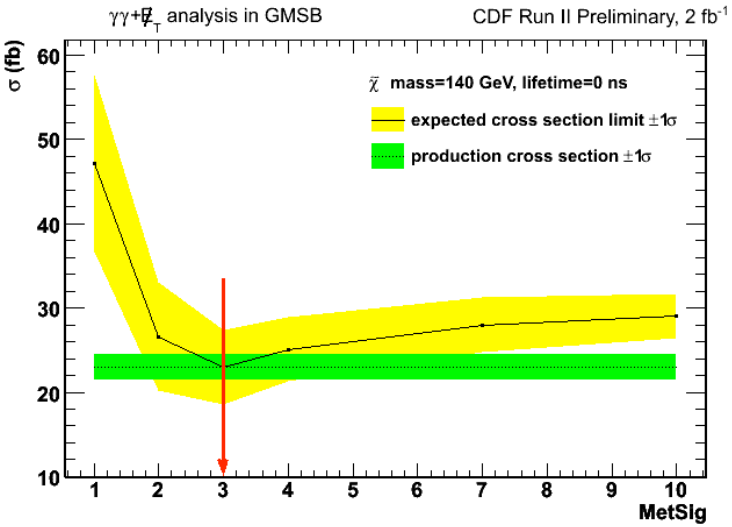
- Example point (100K Events)
  $m(\chi^0_1)$=140 GeV, τ (χ^0_1)=0 ns
- Acceptance : 9.21±1.66 (%)
- Luminosity Error : 6 %

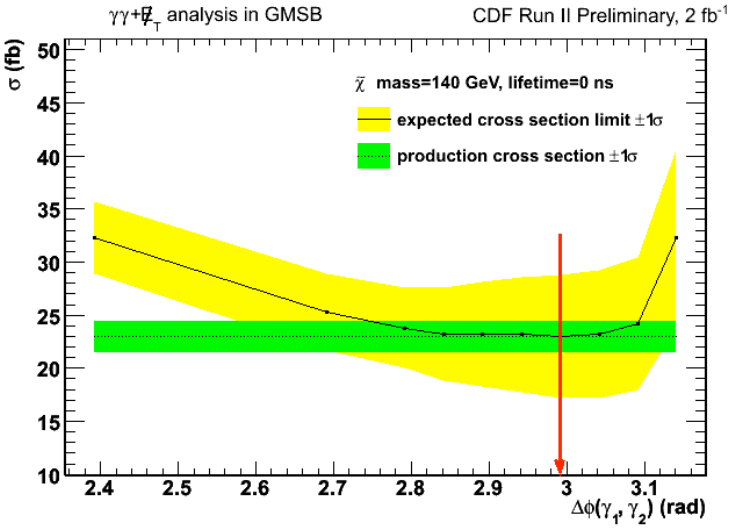
σ_{exp} = 22.24 fb
σ_{prod} = 22.97 fb

Background Estimations	
EWK	0.39 ± 0.14 ± 0.11
Non-Collision	0.049 ± 0.042 ± 0.028
Tri-Pho	0.00 ± 0.180 ± 0.035
Wrong Vertex	0.00 ± 0.081 ± 0.008
QCD	0.1 ± 0.1 ± 0.0
Total	0.62 ± 0.26 ± 0.12

95% C.L. Cross Section Limit: H_T, MetSig, $\Delta\phi(\gamma_1,\gamma_2)$







While varying a cut all other variables held at optimal cuts

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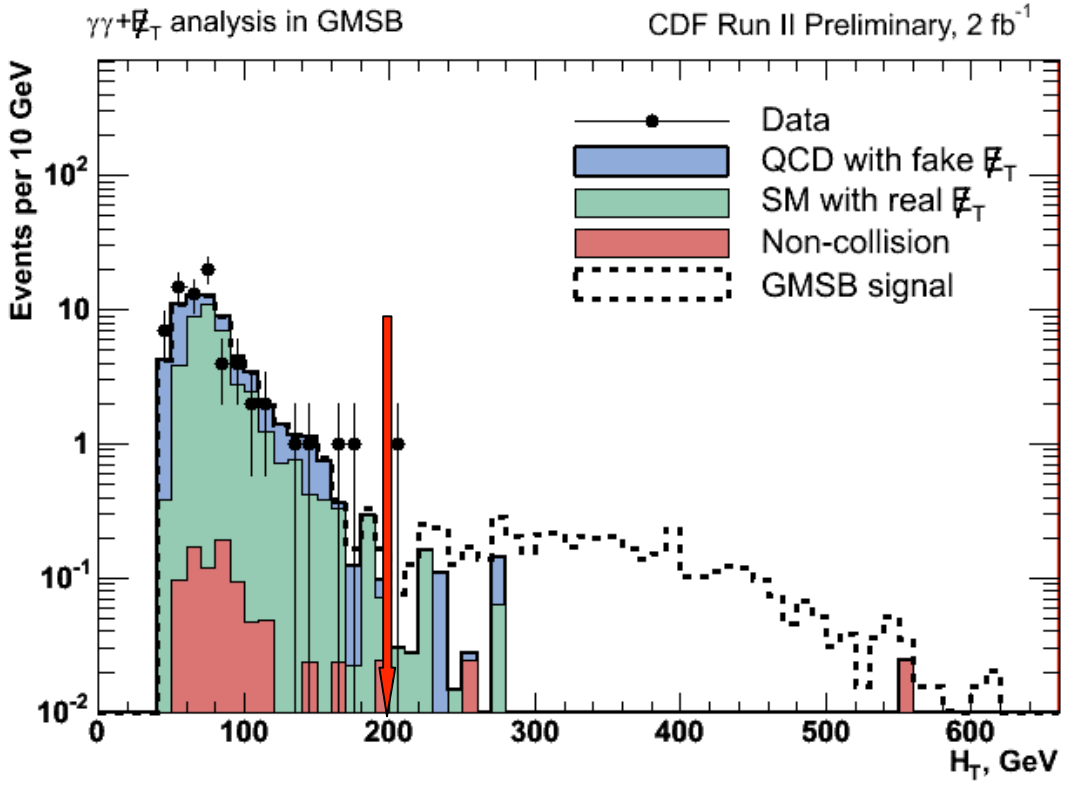
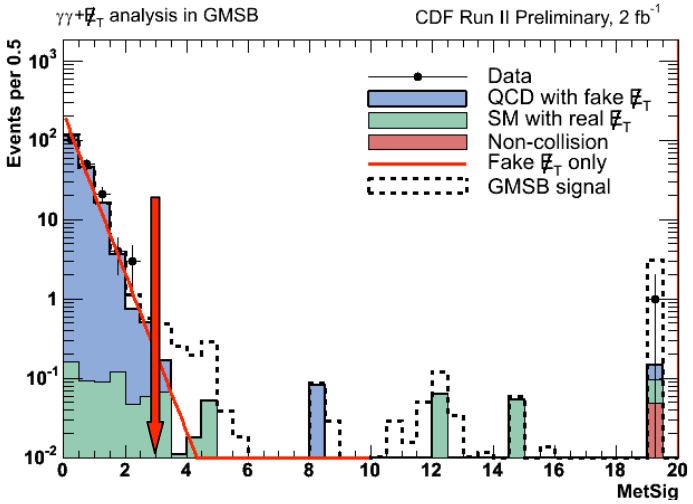
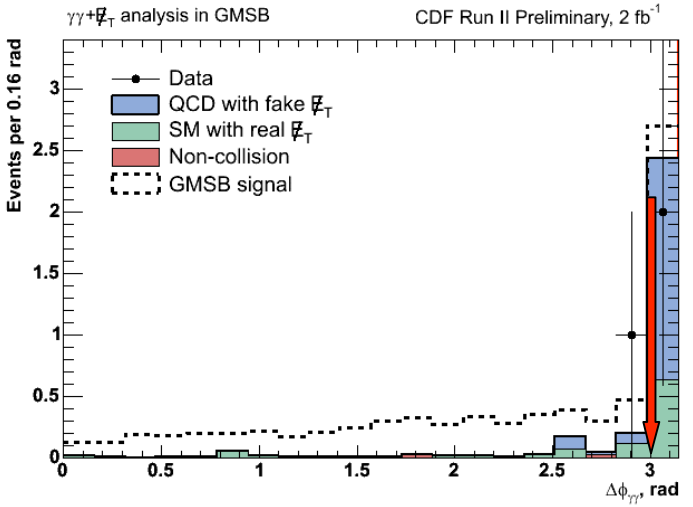
N-1 Plot Plots

We open the box: 1 event observed







- For a distribution all other variables held at optimal cuts
- Everything is well modeled

October 16, 2008

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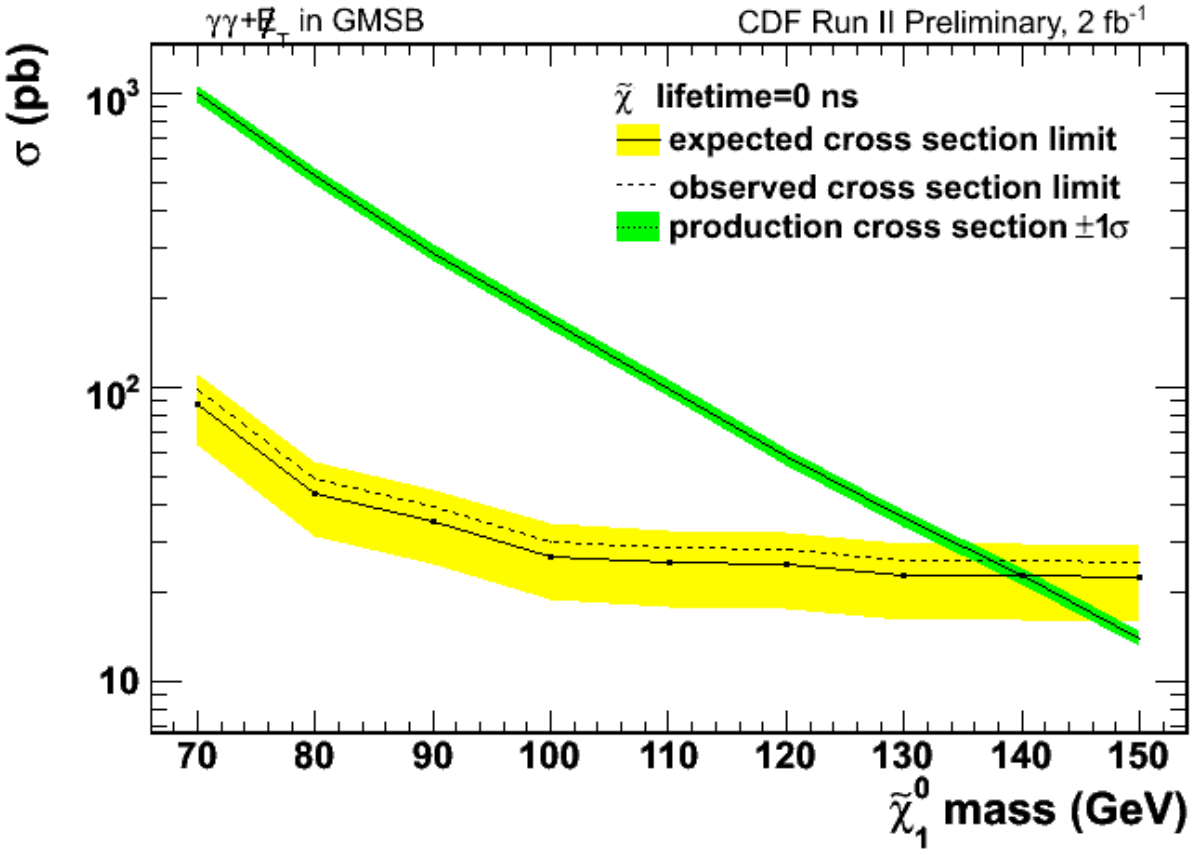
Cross Section Limits vs. Neutralino mass for τ = 0 ns



- Using the same set of optimal cuts:
  - Ht > 200 GeV
  - $\Delta\phi(\gamma_1,\gamma_2) < \pi - 0.15$ rad
  - MetSig >3
- Exclude neutralino mass up to
  - 140 GeV for τ=0 ns

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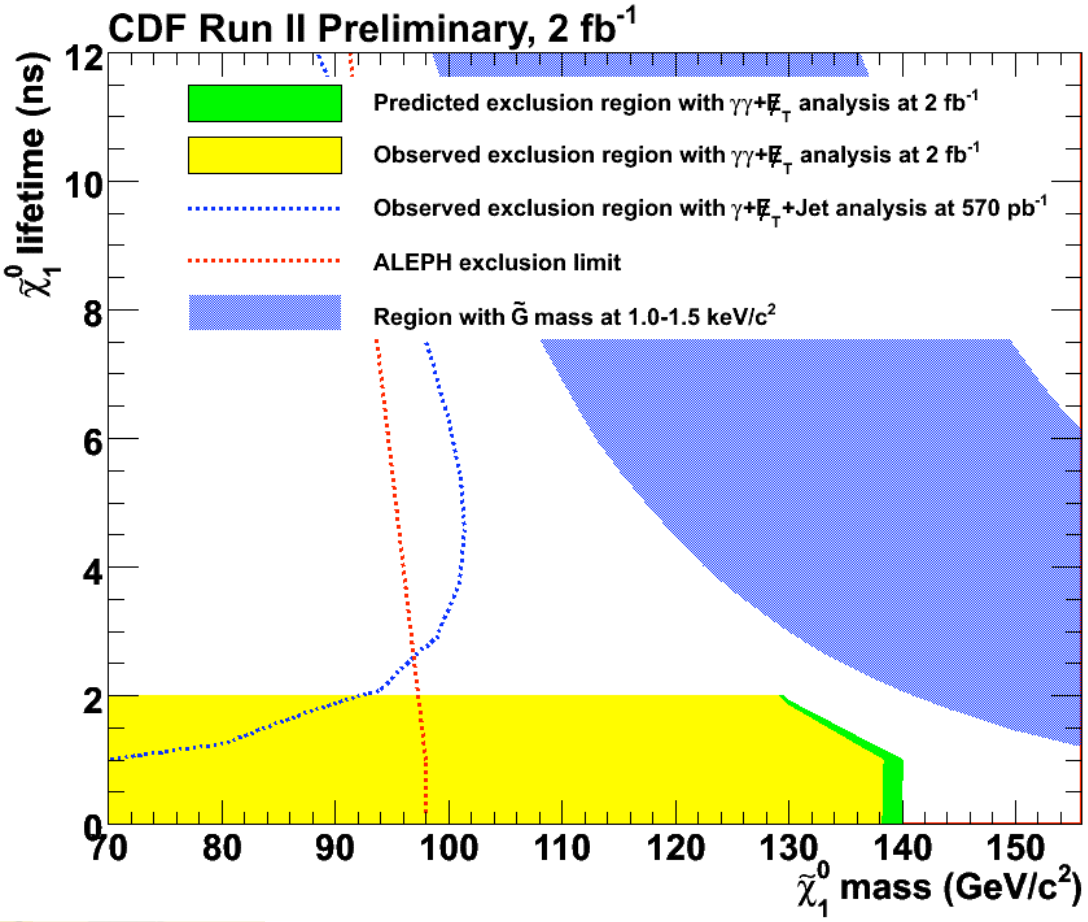
Exclusion Region



- Exclude up to ~ 140 GeV at 0 and 1 ns. (Beyond DØ Limit = 125 GeV)
- New Limits extend the sensitivity in both mass and lifetime. (goes above the Delayed Photon Analysis)
- We are nearing the cosmology favored region (blue band)

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Conclusion and Plan

- Exclude neuralino mass 140 GeV for lifetime=0, 1 ns.
- Next generation delayed photon analysis is coming soon - sensitive to higher lifetimes (above ~ 2 ns).
- Plan to bless for PANIC
- Finishing studies of the systematic errors and comparing to the previous results. Nearly finished.
- Add more data up to 3 fb^{-1} for paper publishing

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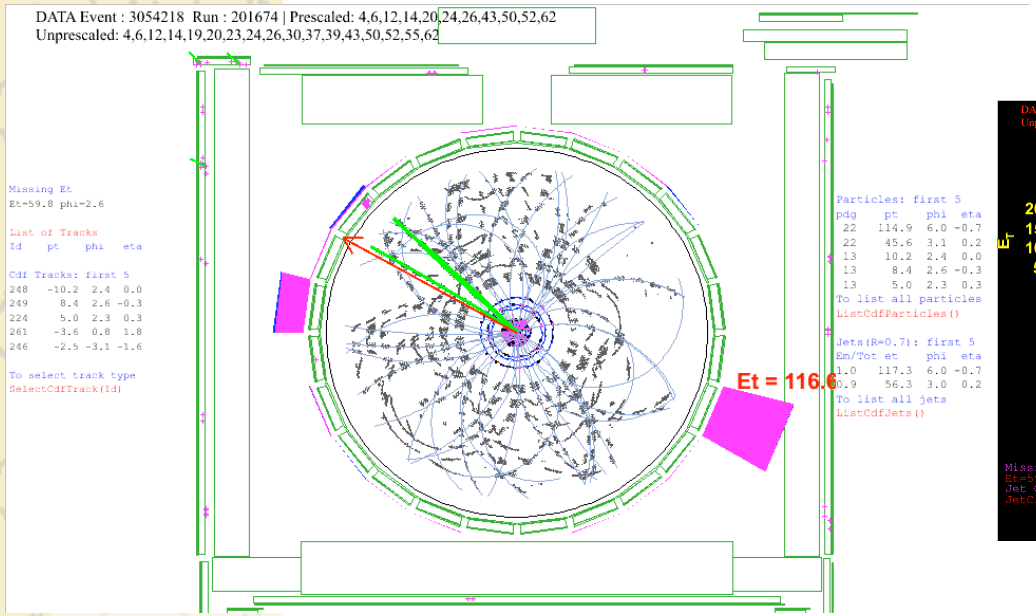
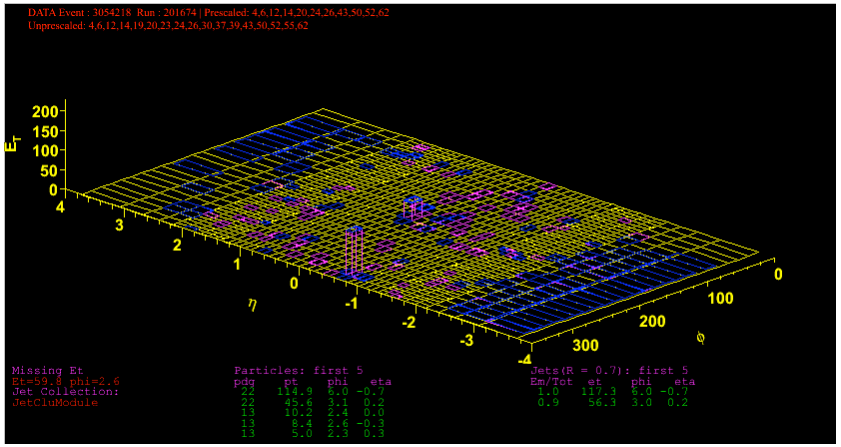
Back Up Slides

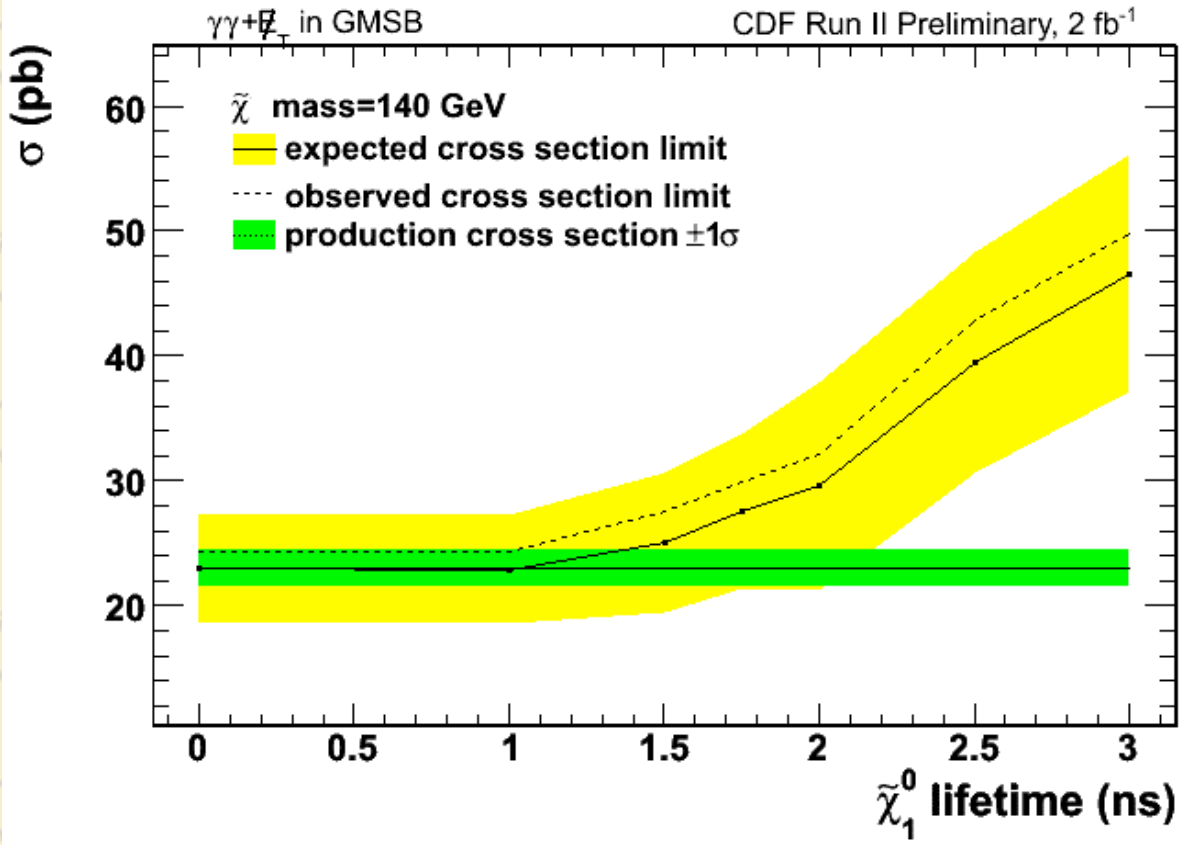
The Event We Observed
Run=201674 Event=3054218





- $E_T(\gamma_1)$=106.5 GeV, $\phi(\gamma_1)$=5.95, $\eta_{Det}(\gamma_1)$=-0.68, CESX=-11.85 CESZ=-135.5, CESStrip=0.52, CESWire=1.16
- $E_T(\gamma_2)$=46.02 GeV, $\phi(\gamma_2)$=3.06, $\eta_{Det}(\gamma_2)$=0.23, CESX=-10.48, CESZ=43.72, CESStrip=-99, CESWire=-99
- $\not\!\!E_T$ =54.98 GeV, $\phi(\not\!\!E_T)$=2.60, MetSig=19
- N_{vx}=2, $N_{jet}(E_T > 15\ \text{GeV})$=0

Cross Section Limits vs. Neutralino lifetime for m = 140 GeV



- Using the same set of optimal cuts:
  - Ht > 200 GeV
  - $\Delta\phi(\gamma_1,\gamma_2) < \pi - 0.15$ rad
  - MetSig >3
- Exclude neutralino lifetime up to
  - ~1 ns for m=140 GeV

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