Potential for Discoveries at the (7 TeV) LHC

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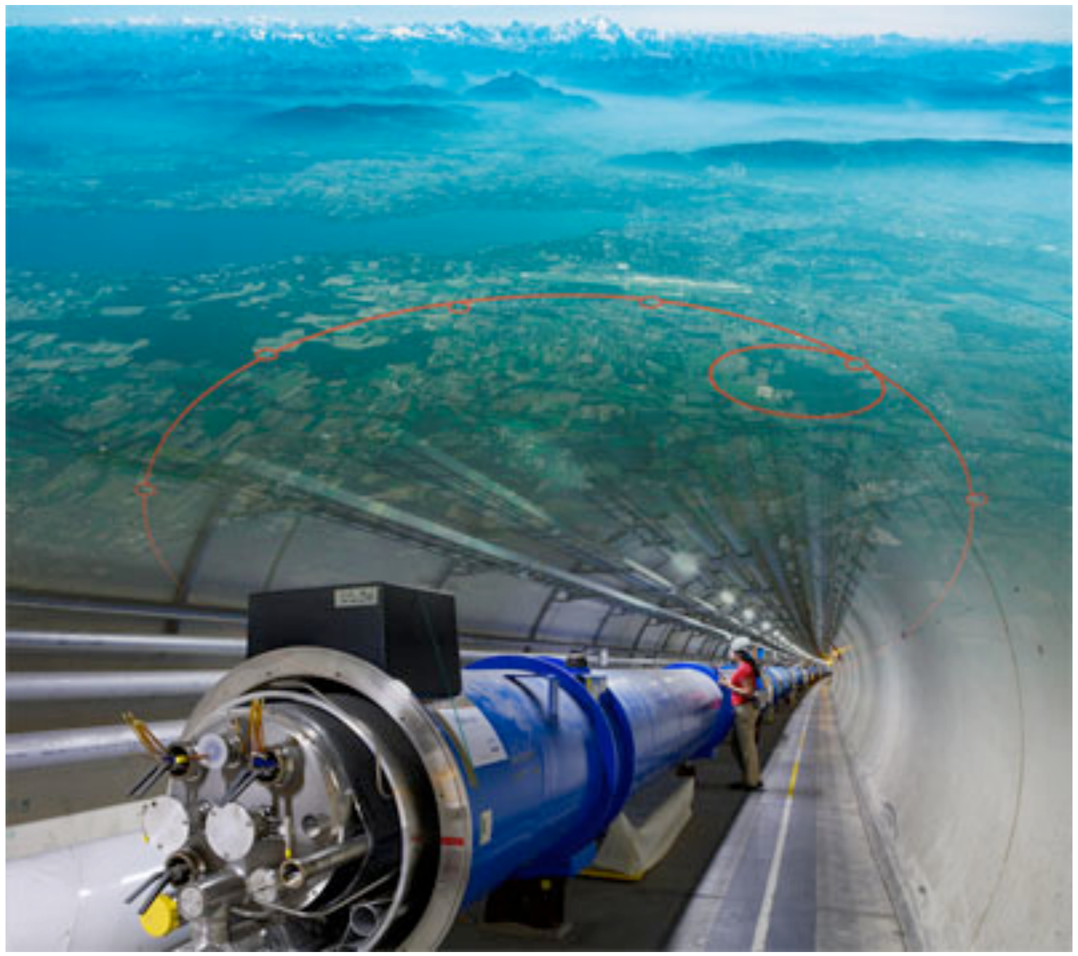
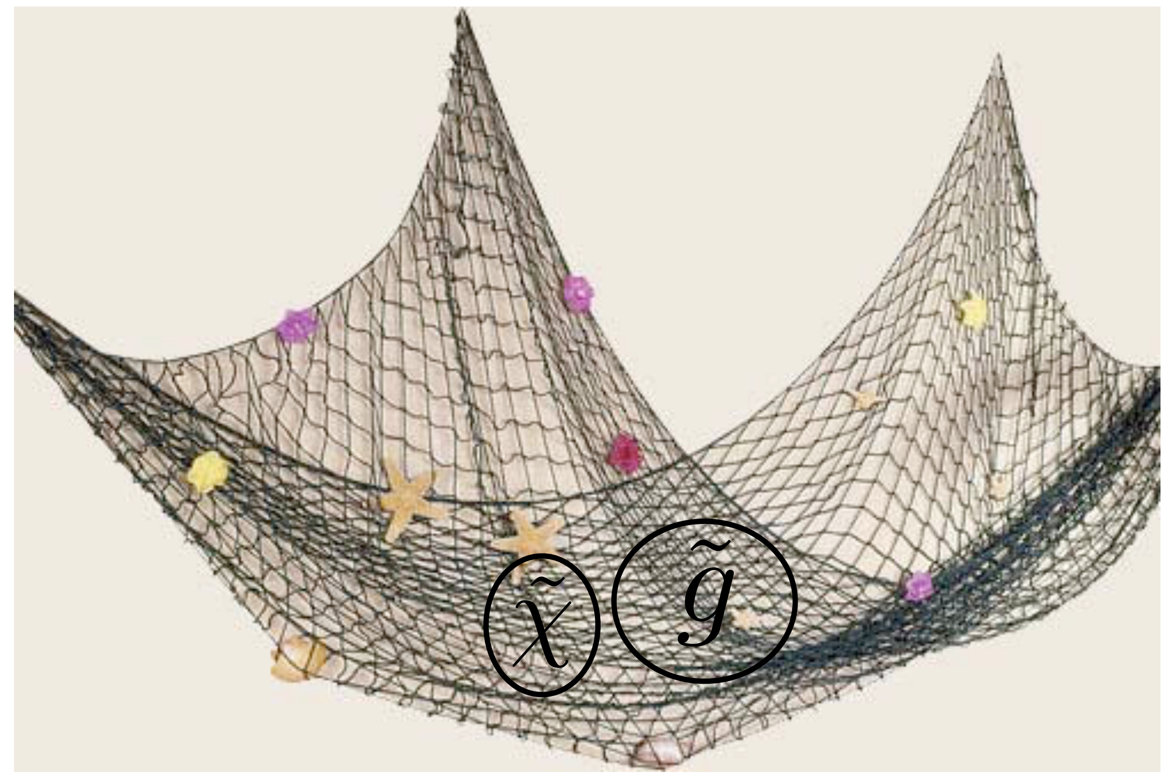
SLAC

With: Daniele Alves and Jay G. Wacker

Based on: arXiv:1003.3886, arXiv:1008.0407, arXiv:1009.xxxx

US ATLAS Hadronic Final State Forum August 23, 2010





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Jets + MET

Large production rates

Reason to be optimistic for seeing excesses

Dark Matter

Wimp Miracle: DM a thermal relic if mass is 100 GeV to 1 TeV

Usually requires a dark sector, frequently contains new colored particles

Outline

- Simplified Models and Tevatron sensitivity
- Early ATLAS results and interpretations
- Prospects for 1 fb^{-1}

Simplified Models

Models are created to solve problems or demonstrate mechanisms

Realistic ones tend to be complicated and most details are irrelevant for searches

Limits of specific theories

Only keep particles and couplings relevant for searches

Captures many specific models (MSSM, UED, etc)

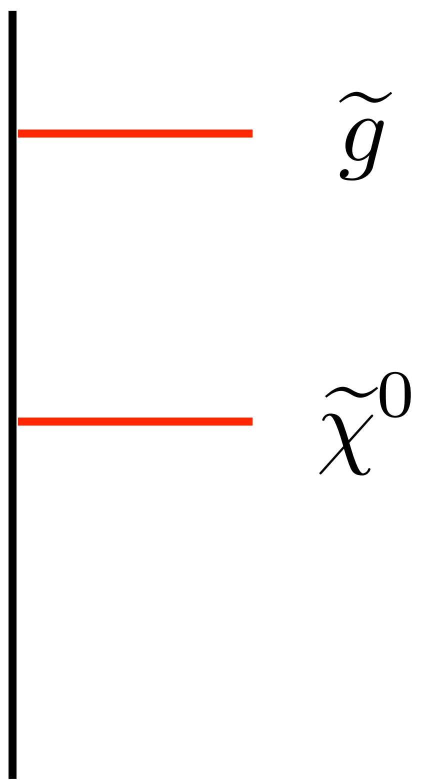
Easy to notice & explore kinematic limits

Alwall, Le, Lisanti, Wacker.
arXiv:0809.3264, arXiv0803.0019

Two Simplified Models

$$pp \to \widetilde{g}\widetilde{g}$$

Direct Decays

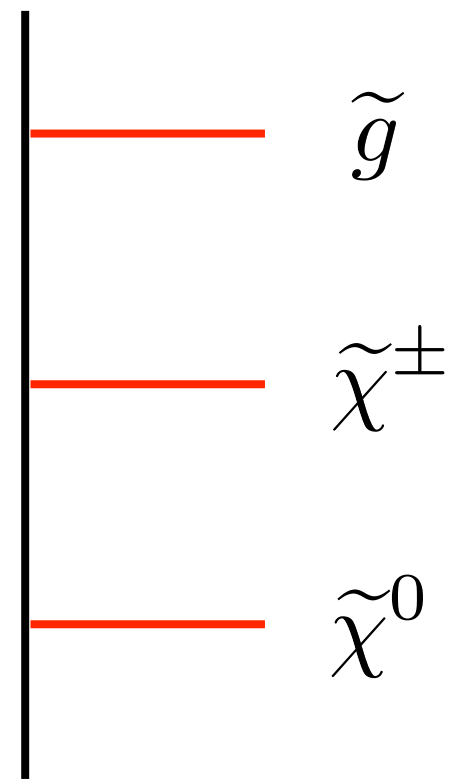


$$\widetilde{g} \to q\bar{q}\widetilde{\chi}^0$$

Free parameters

$$\sigma_{pp\to\widetilde{g}\widetilde{g}} \quad m_{\widetilde{g}} \quad m_{\widetilde{\chi}^0}$$

One Step Decays



$$\widetilde{g} \to qq'\widetilde{\chi}^{\pm} \to qq'(W^*\chi^0)$$

Free parameters

$$\sigma_{pp\to\widetilde{g}\widetilde{g}} \quad m_{\widetilde{g}} \quad m_{\widetilde{\chi}^0} \; m_{\chi^{\pm}}$$

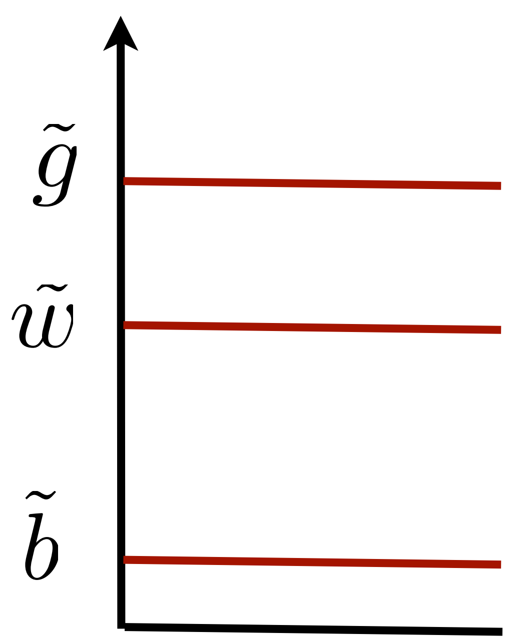
Spectrum in Different Theories

MSSM

High Cut-Off

Large Mass Splittings

$$\delta m = \frac{g^2}{16\pi^2}\, m \, \log \Lambda$$

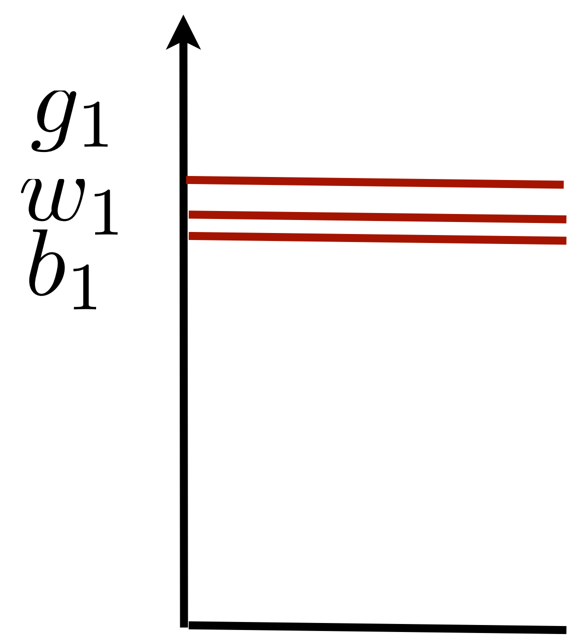


Universal Extra Dimensions

Low Cut-Off

Small Mass Splittings

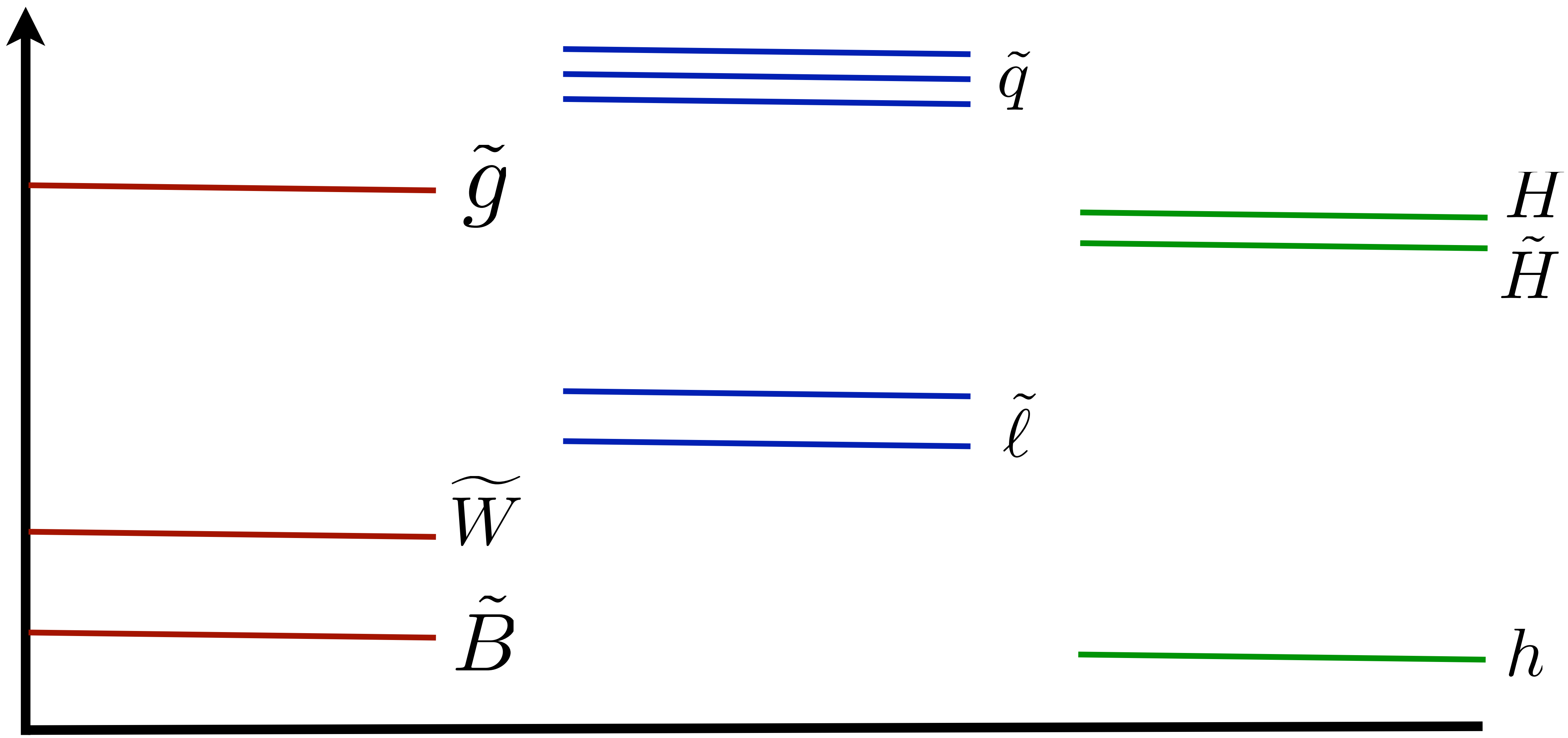
$$\delta m = \frac{g^2}{16\pi^2}\frac{\Lambda^2}{m}$$



mSugra has "Gaugino Mass Unification"

$$m_{\tilde{g}} : m_{\tilde{W}} : m_{\tilde{B}} = \alpha_3 : \alpha_2 : \alpha_1 \simeq 6 : 2 : 1$$

Chosen benchmarks miss some important kinematics



Lack of diversity (contrast with pMSSM)

Berger, Gainer, Hewett, Rizzo. arXiv:0812.0980

Outline

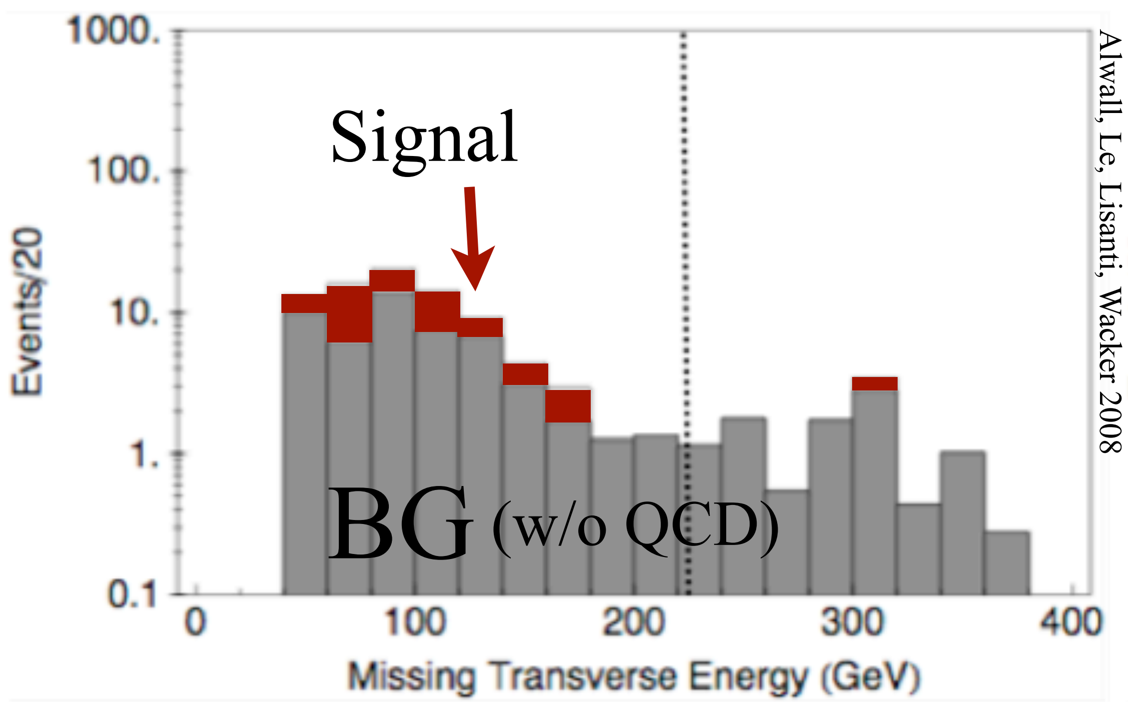
- Simplified Models and Tevatron sensitivity

  Early ATLAS results and interpretations

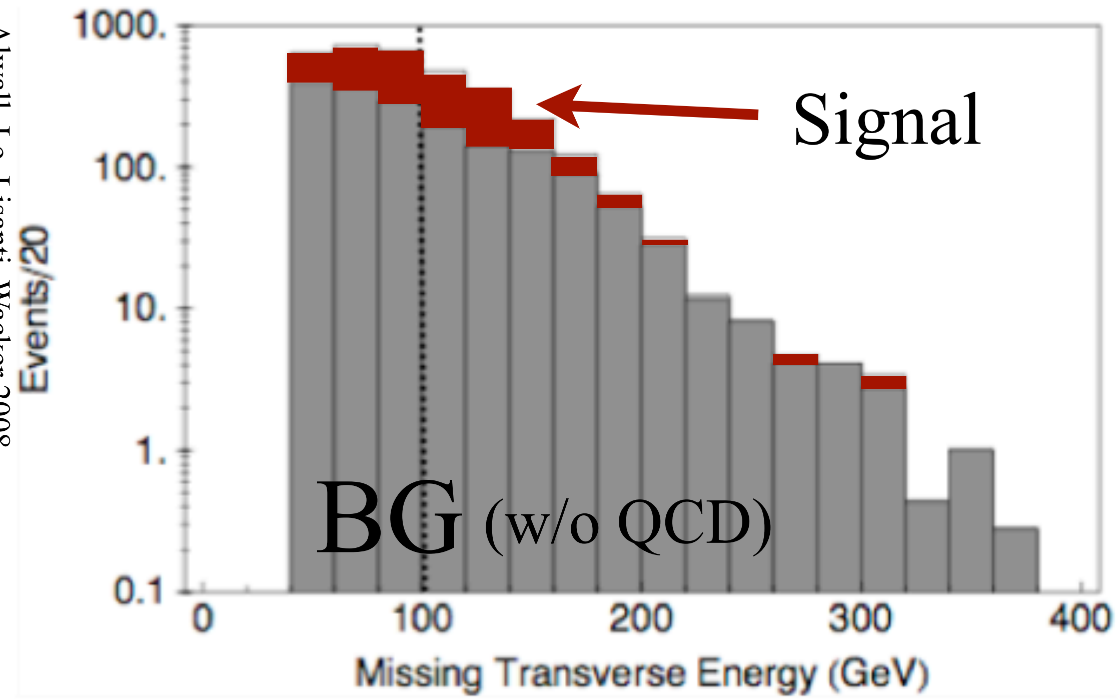
  Prospects for 1 fb^{-1}

Expected Sensitivity at the Tevatron

$$(m_{\tilde{g}} = 210\text{GeV}, m_{LSP} = 100\text{GeV})$$



$H_T \geq 300$ GeV $\quad \not{E}_T \geq 225$ GeV



$H_T \geq 150$ GeV $\quad \not{E}_T \geq 100$ GeV

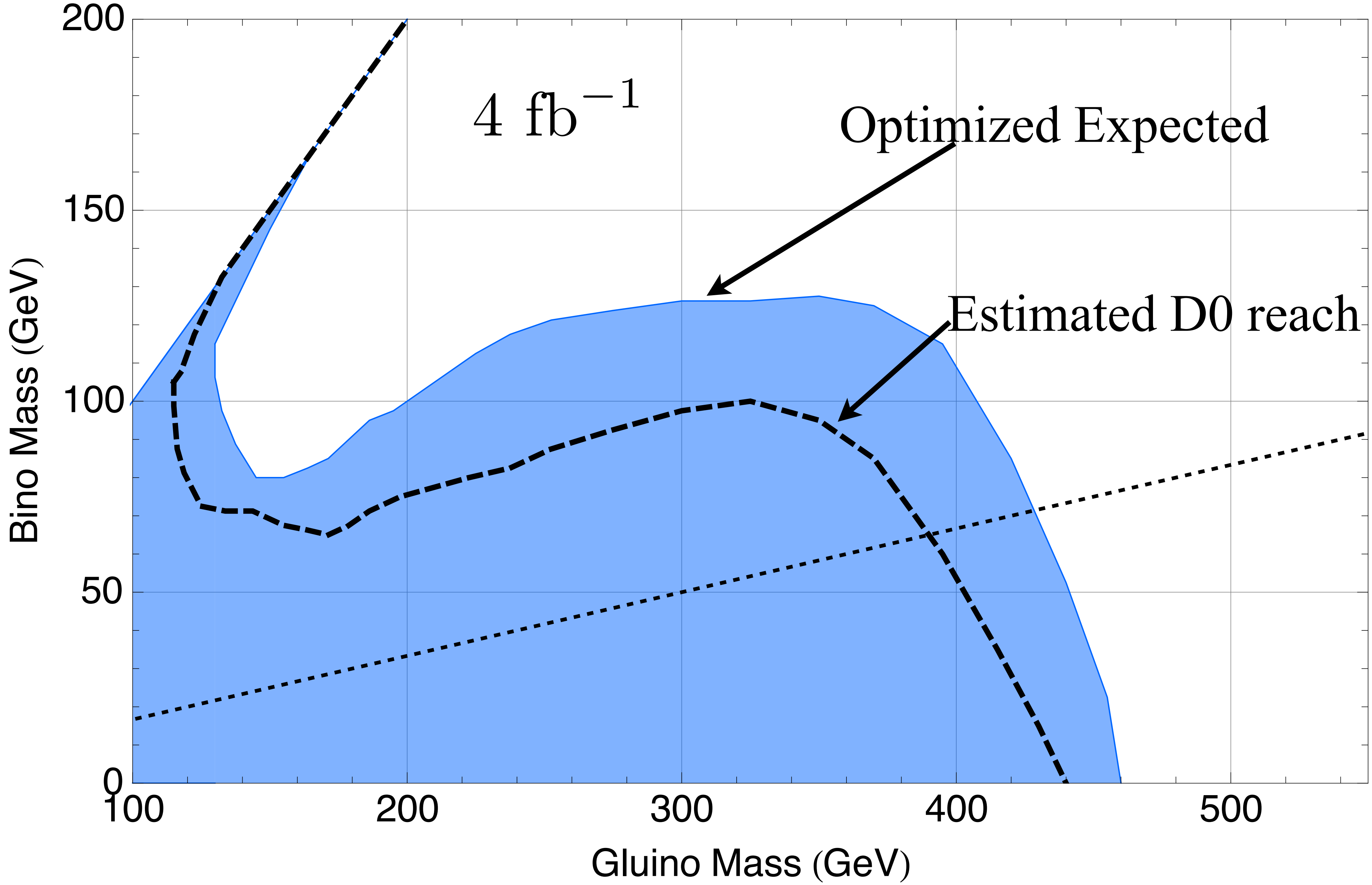
Alwall, Le, Lisanti, Wacker.
arXiv:0809.3264, arXiv0803.0019

Difficult Searches

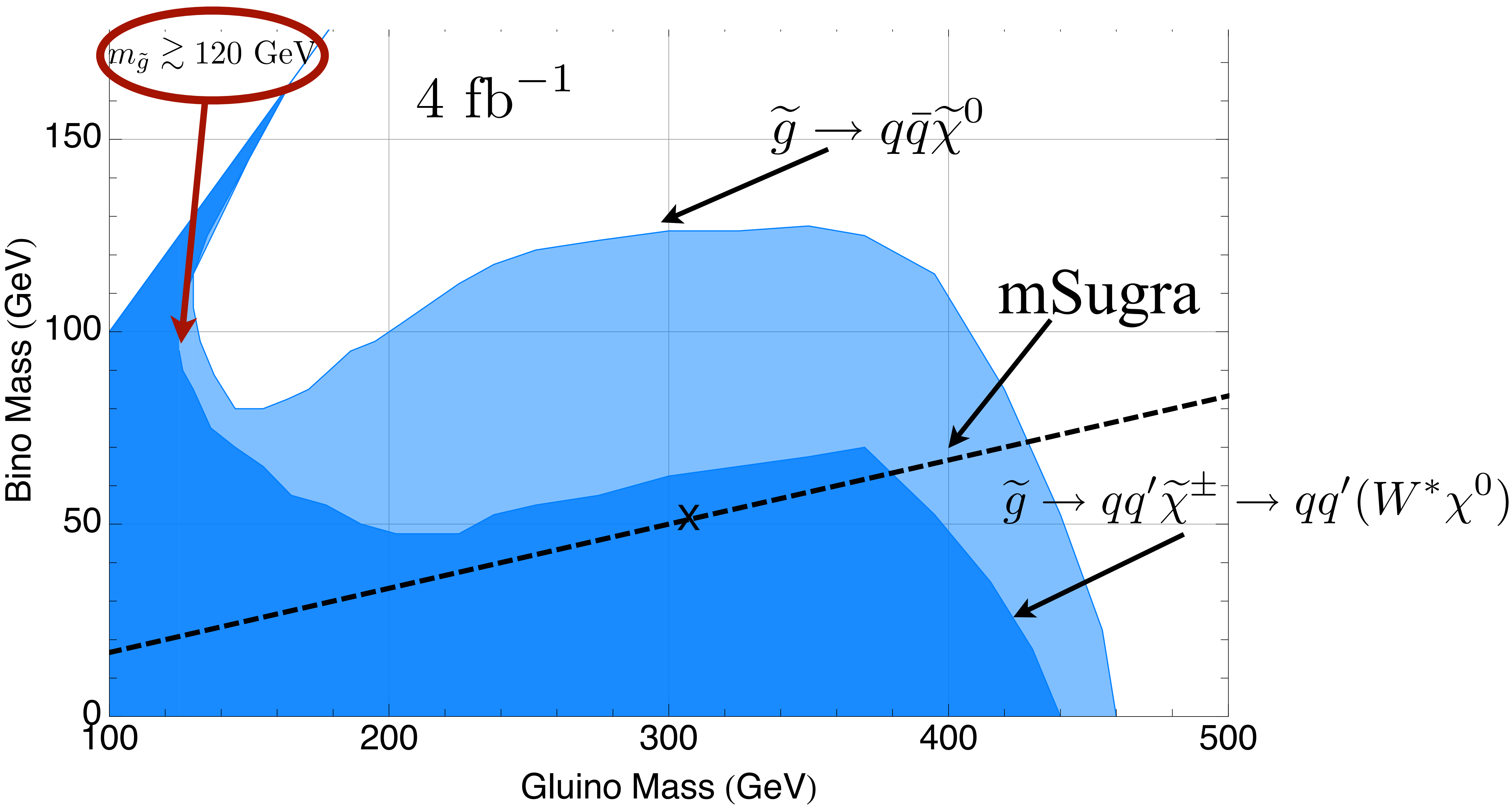
	$1j + \not{E}_T$	$2j + \not{E}_T$	$3j + \not{E}_T$	$4^+j + \not{E}_T$
$E_{T\,j_1}$	≥ 150	≥ 35	≥ 35	≥ 35
$E_{T\,j_2}$	< 35	≥ 35	≥ 35	≥ 35
$E_{T\,j_3}$	< 35	< 35	≥ 35	≥ 35
$E_{T\,j_4}$	< 20	< 20	< 20	≥ 20
H_T	Various	Various	Various	Various
$\not{E}_T$	Various	Various	Various	Various

Vary Signal Region Cuts?

$$\widetilde{g} \to q\bar{q}\widetilde{\chi}^0$$



Gluino Expected Sensitivity at the Tevatron



Lessons Learned So Far

Simplified Models let you capture different kinematic limits

Example of Tevatron's reach

Outline

Simplified Models and Tevatron sensitivity

- Early ATLAS results and interpretations

Prospects for $1\ \mathrm{fb}^{-1}$

ATLAS NOTE

ATLAS-CONF-2010-065

20 July, 2010

Early supersymmetry searches in channels with jets and missing transverse momentum with the ATLAS detector

Abstract

This note describes a first set of measurements of supersymmetry-sensitive variables in the final states with jets, missing transverse momentum and no leptons from the $\sqrt{s} = 7$ TeV proton-proton collisions at the LHC. The data were collected during the period March 2010 to July 2010 and correspond to a total integrated luminosity of $70 \pm 8\,\mathrm{nb}^{-1}$. We find agreement between data and Monte Carlo simulations indicating that the Standard Model backgrounds to searches for new physics in these channels are under control.

ATLAS Search

$$\mathcal{L} = 70\ \mathrm{nb}^{-1}$$

Performed 4 searches

Cut	Topology	$1j + \not\!\!E_T$	$2^+j + \not\!\!E_T$	$3^+j + \not\!\!E_T$	$4^+j + \not\!\!E_T$
1	p_{T1}	$> 70\,\mathrm{GeV}$	$> 70\,\mathrm{GeV}$	$> 70\,\mathrm{GeV}$	$> 70\,\mathrm{GeV}$
2	p_{Tn}	$\leq 30\,\mathrm{GeV}$	$> 30\,\mathrm{GeV}(n=2)$	$> 30\,\mathrm{GeV}(n=2,3)$	$> 30\,\mathrm{GeV}(n=2-4)$
3	$\not\!\!E_{T\,\mathrm{EM}}$	$> 40\,\mathrm{GeV}$	$> 40\,\mathrm{GeV}$	$> 40\,\mathrm{GeV}$	$> 40\,\mathrm{GeV}$
4	$p_{T\,\ell}$	$\leq 10\,\mathrm{GeV}$	$\leq 10\,\mathrm{GeV}$	$\leq 10\,\mathrm{GeV}$	$\leq 10\,\mathrm{GeV}$
5	$\Delta\phi(j_n, \not\!\!E_{T\,\mathrm{EM}})$	none	$[> 0.2, > 0.2]$	$[> 0.2, > 0.2, > 0.2]$	$[> 0.2, > 0.2, > 0.2, \mathrm{none}]$
6	$\not\!\!E_{T\,\mathrm{EM}}/M_{\mathrm{eff}}$	none	> 0.3	> 0.25	> 0.2
	N_{Pred}	46^{+22}_{-14}	6.6 ± 3.0	1.9 ± 0.9	1.0 ± 0.6
	N_{Obs}	73	4	0	1

Low instantaneous luminosity allows low triggers.

Loose cuts.

Backgrounds under good control

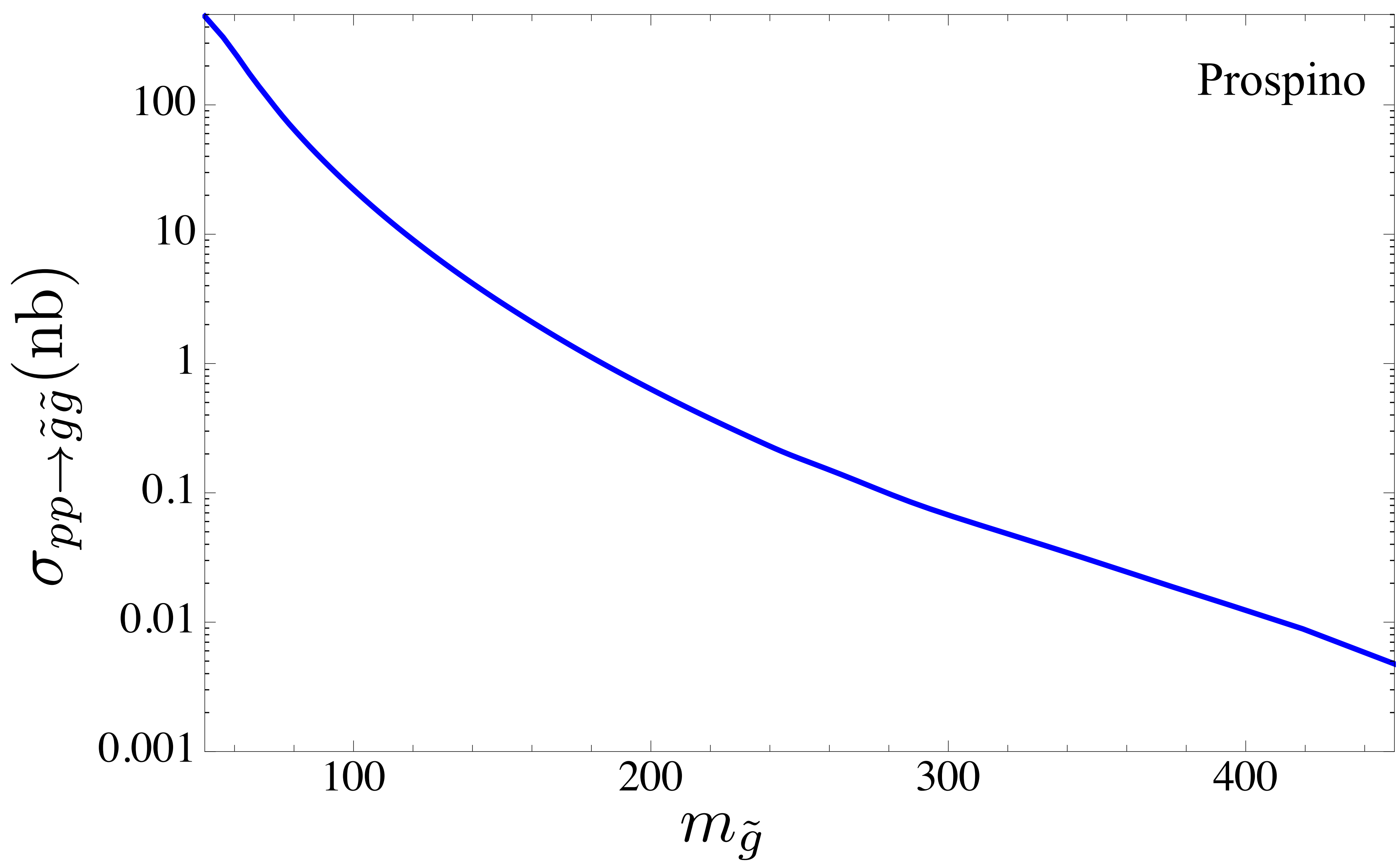
Sets limit on

$$\sigma(pp \to \tilde{g}\tilde{g}X)\ \epsilon$$

Cut	Topology	$1j + \not{E}_T$	$2^+j + \not{E}_T$	$3^+j + \not{E}_T$	$4^+j + \not{E}_T$
1	p_{T1}	$> 70\,\text{GeV}$	$> 70\,\text{GeV}$	$> 70\,\text{GeV}$	$> 70\,\text{GeV}$
2	p_{Tn}	$\leq 30\,\text{GeV}$	$> 30\,\text{GeV}(n = 2)$	$> 30\,\text{GeV}(n = 2, 3)$	$> 30\,\text{GeV}(n = 2 - 4)$
3	$\not{E}_{T\,\text{EM}}$	$> 40\,\text{GeV}$	$> 40\,\text{GeV}$	$> 40\,\text{GeV}$	$> 40\,\text{GeV}$
4	$p_{T\,\ell}$	$\leq 10\,\text{GeV}$	$\leq 10\,\text{GeV}$	$\leq 10\,\text{GeV}$	$\leq 10\,\text{GeV}$
5	$\Delta\phi(j_n, \not{E}_{T\,\text{EM}})$	none	$[> 0.2, > 0.2]$	$[> 0.2, > 0.2, > 0.2]$	$[> 0.2, > 0.2, > 0.2, \text{none}]$
6	$\not{E}_{T\,\text{EM}}/M_{\text{eff}}$	none	> 0.3	> 0.25	> 0.2
	N_{Pred}	46^{+22}_{-14}	6.6 ± 3.0	1.9 ± 0.9	1.0 ± 0.6
	N_{Obs}	73	4	0	1
	$\sigma(pp \to \tilde{g}\tilde{g}X)\epsilon\vert_{95\%\ \text{C.L.}}$	663 pb	46.4 pb	20.0 pb	56.9 pb

$3^+j + \not{E}_T$ usually most effective

How far can you reach with $\sigma(pp \to \tilde{g}\tilde{g}) = 20\ \text{pb}$?



Can get above the Tevatron's sensitivity with reasonable efficiencies

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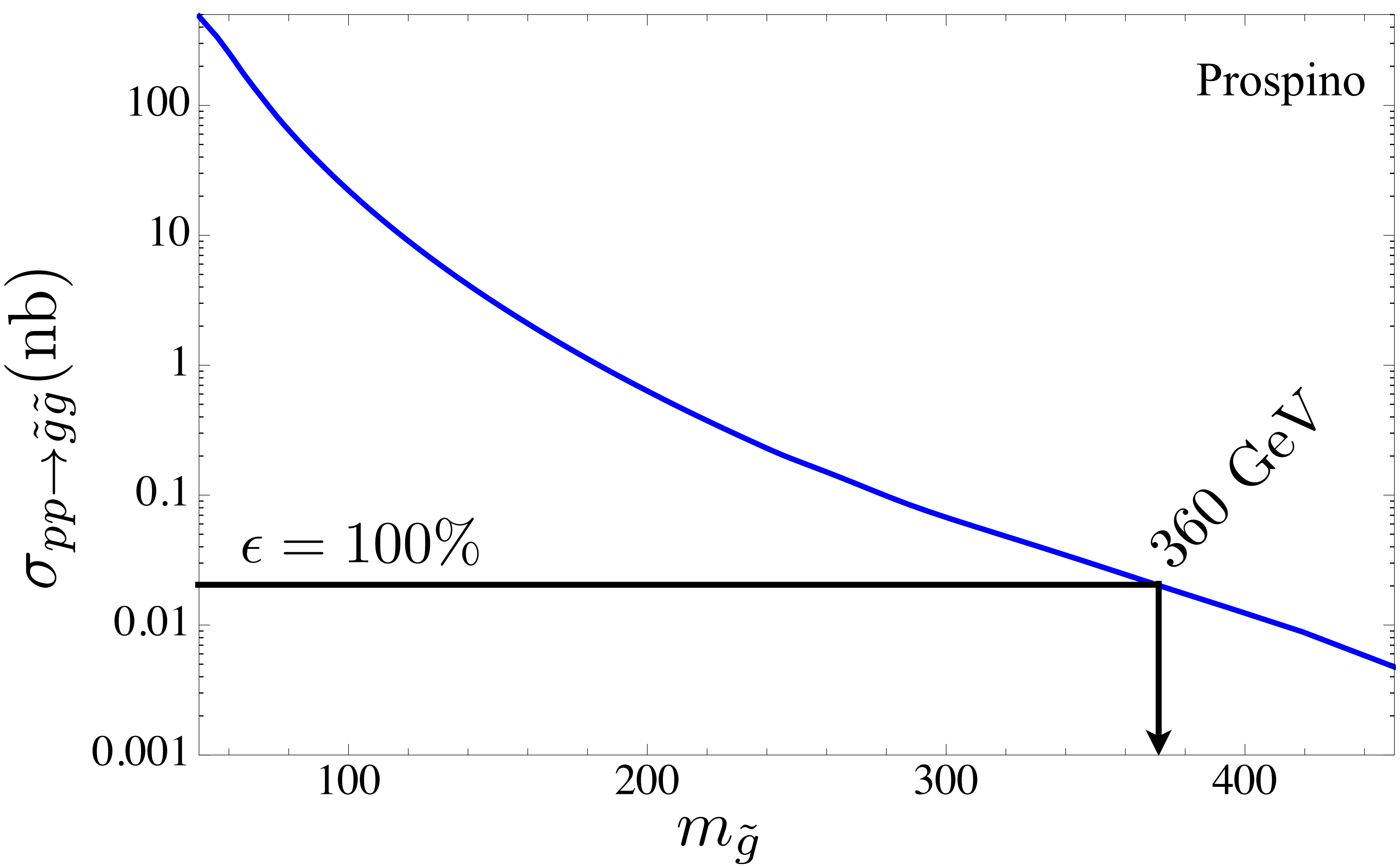

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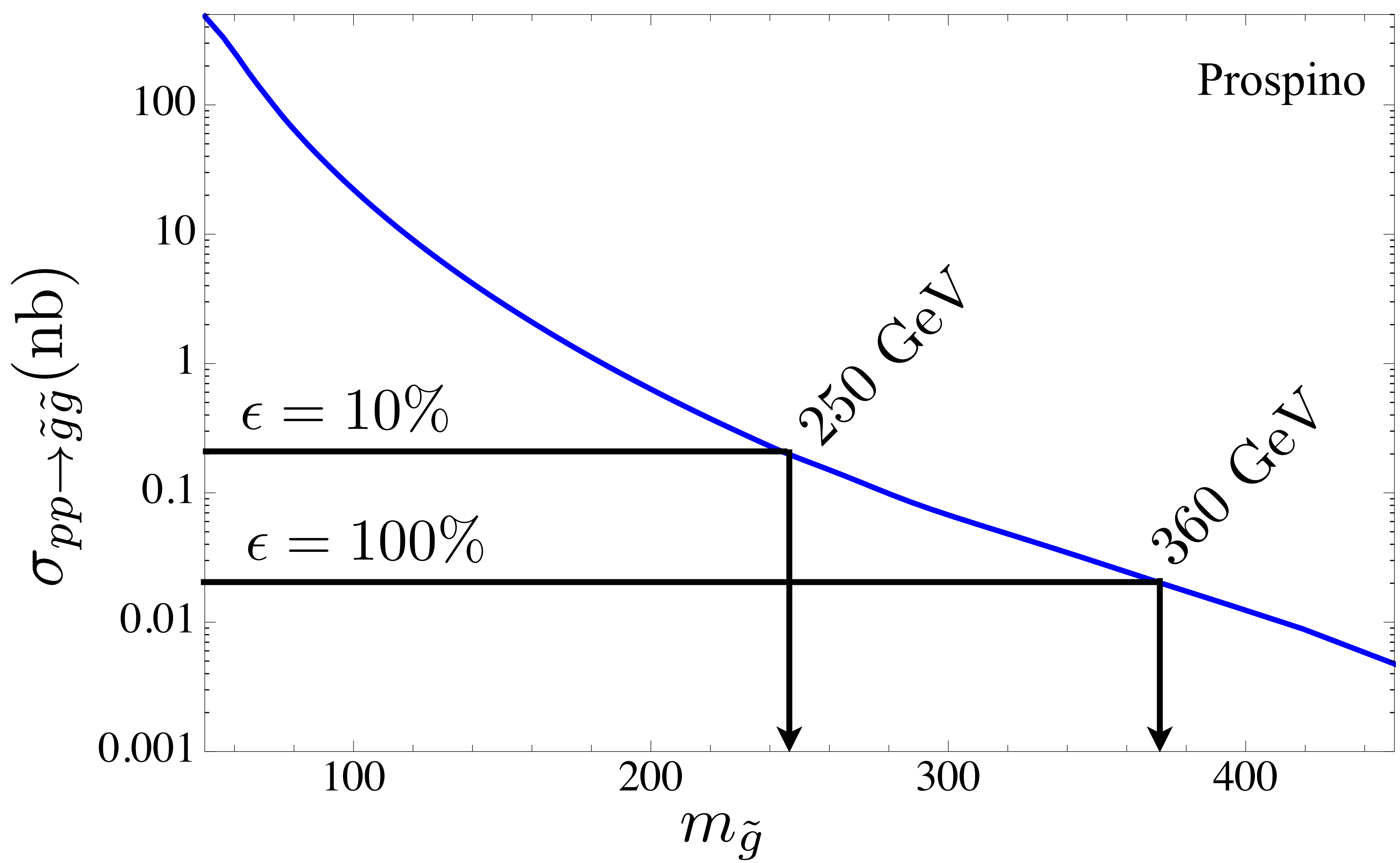
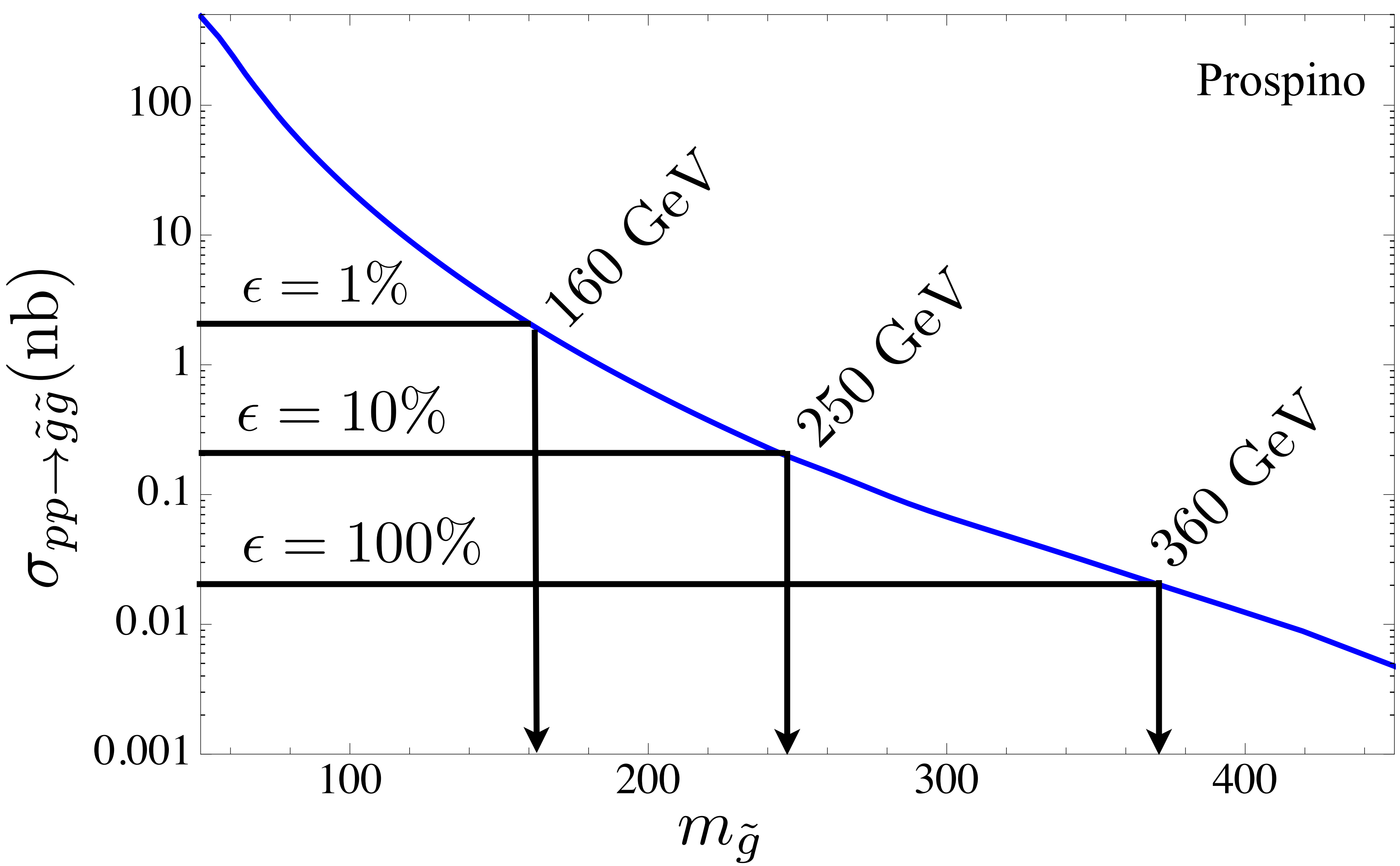


Can get above the Tevatron's sensitivity with reasonable efficiencies

How far can you reach with $\sigma(pp \to \tilde{g}\tilde{g}) = 20$ pb ?



Can get above the Tevatron's sensitivity with reasonable efficiencies

Sensitivity Estimate

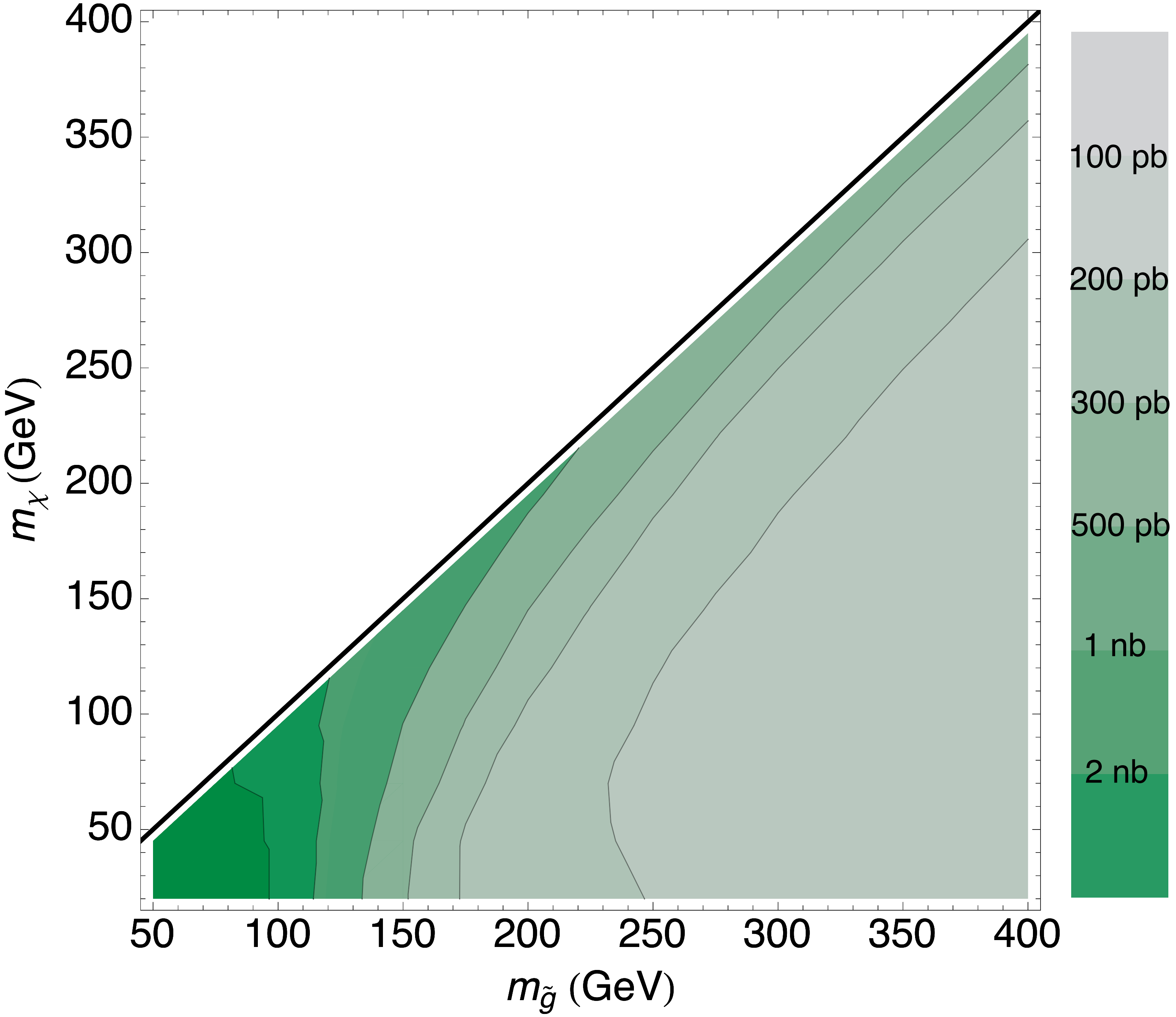
Madgraph $\longrightarrow$ Pythia $\longrightarrow$ PGS $\longrightarrow$ Cuts

$pp \rightarrow \tilde{g}\tilde{g} + \leq 2j$ $\quad\quad$ $\widetilde{g} \rightarrow q\bar{q}\widetilde{\chi}^0$

(MLM matched) $\quad$ $\widetilde{g} \rightarrow qq'\widetilde{\chi}^{\pm} \rightarrow qq'(W^*\chi^0)$

Putting it all together

$$\tilde{g} \rightarrow \chi q \bar{q}$$



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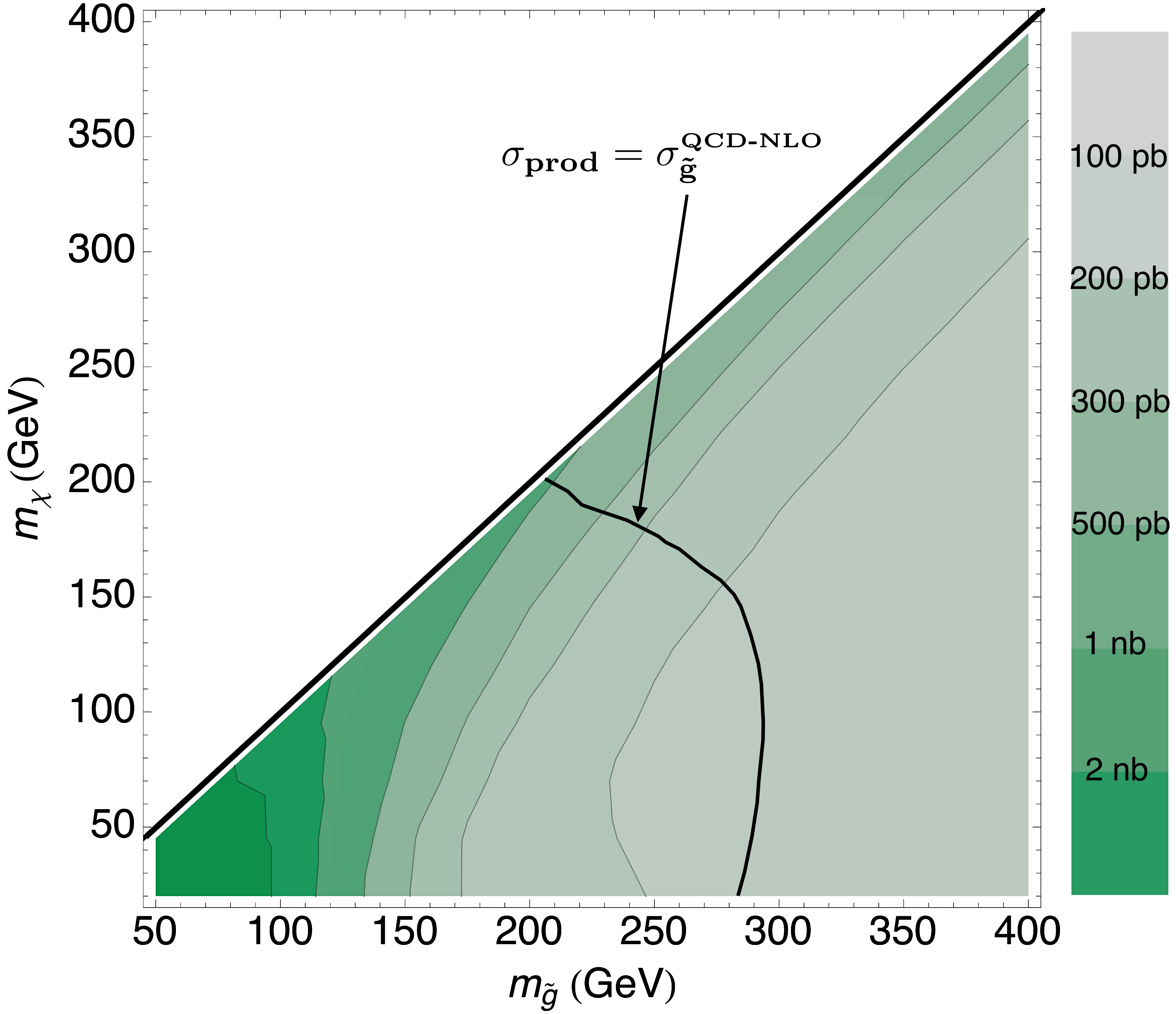
Putting it all together

$$\tilde{g} \rightarrow \chi q \bar{q}$$



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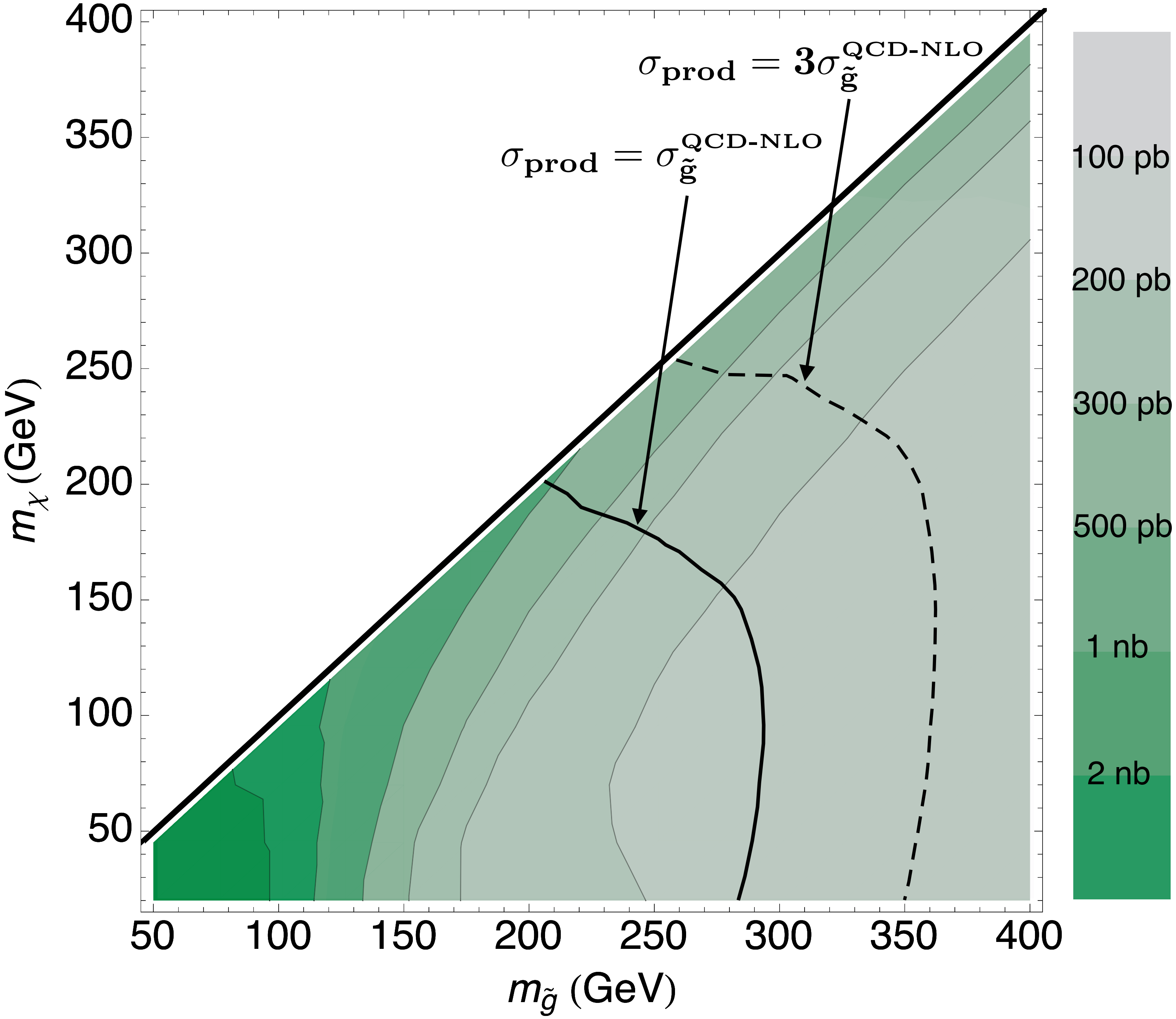

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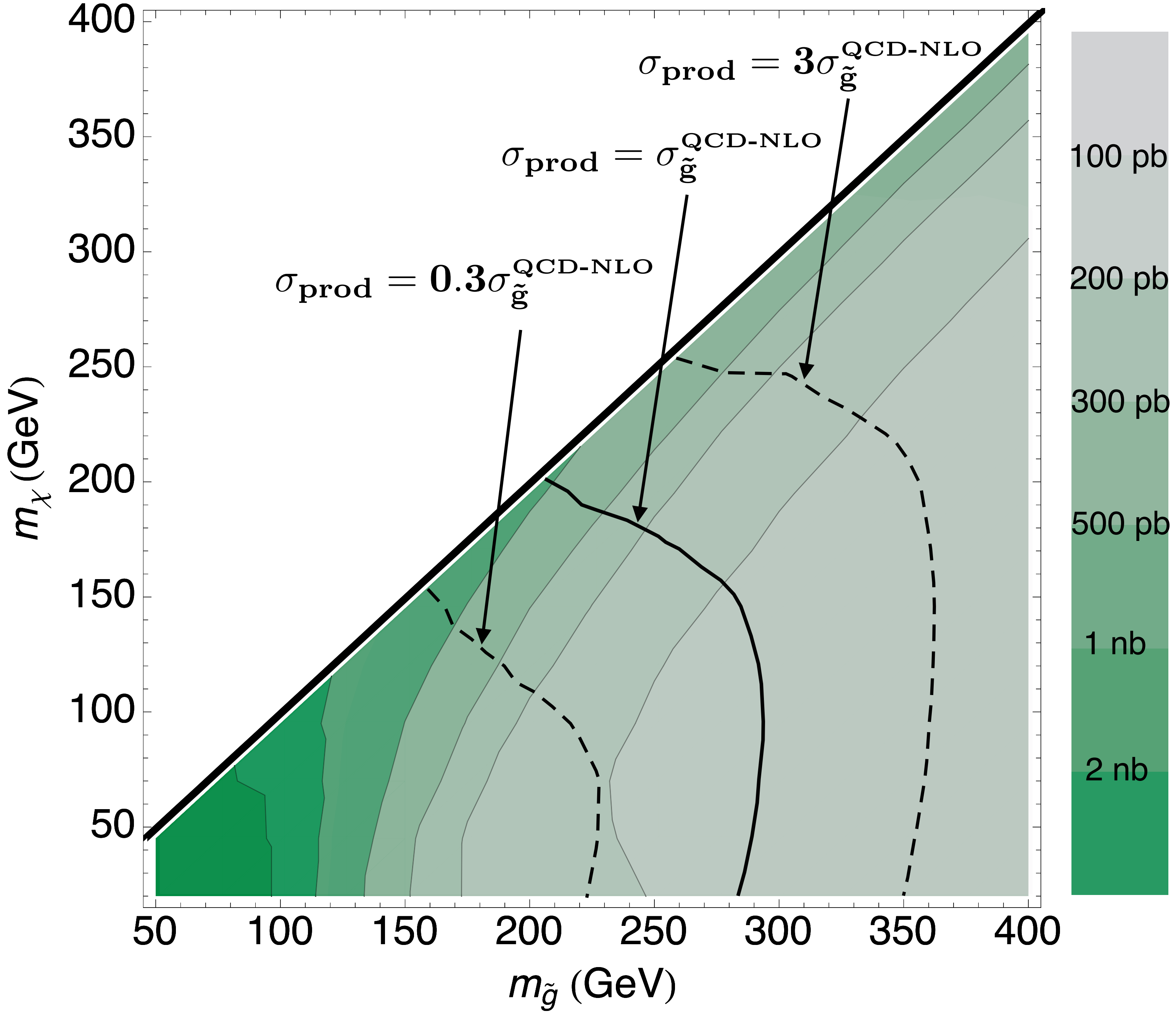

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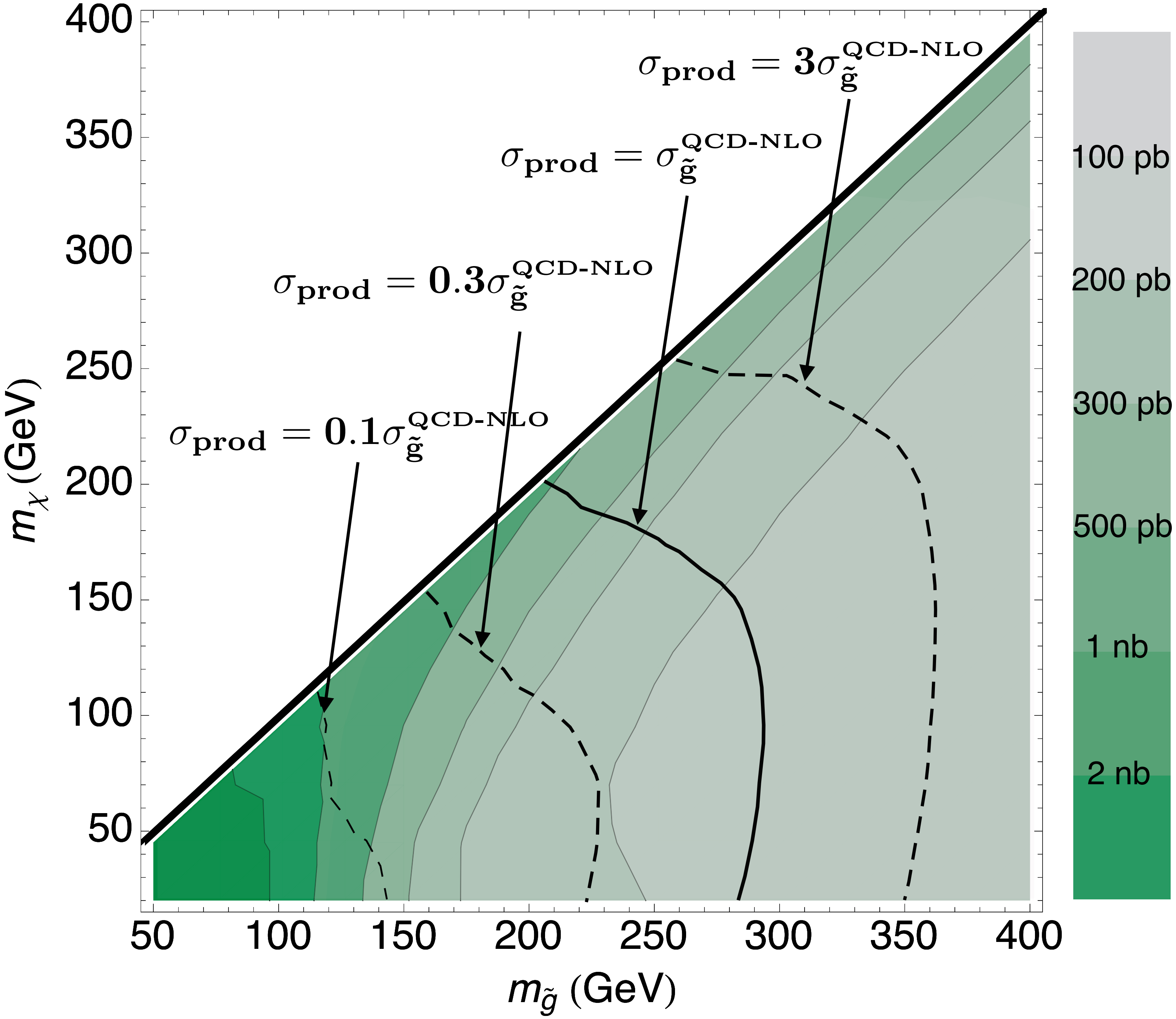

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Putting it all together

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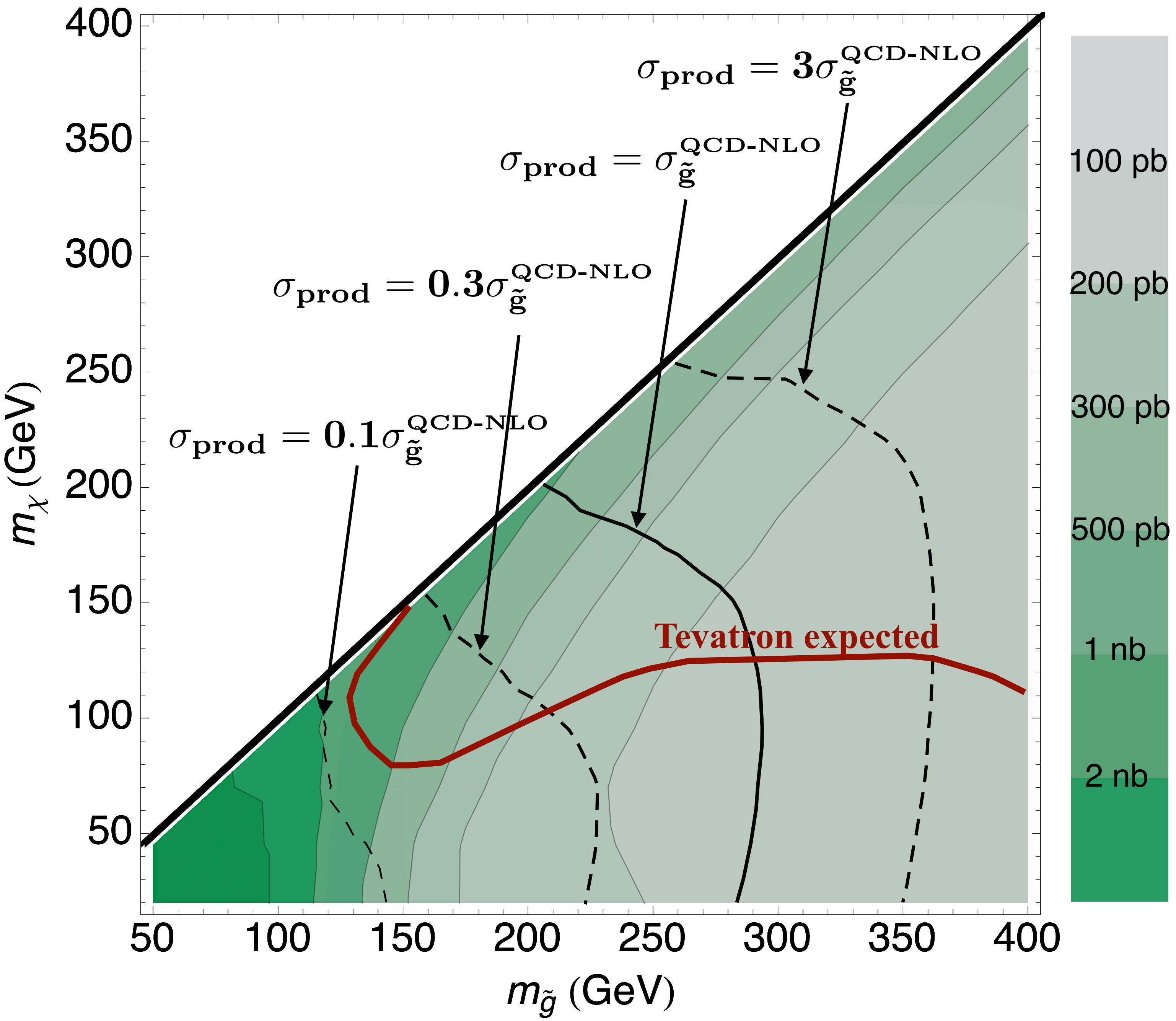
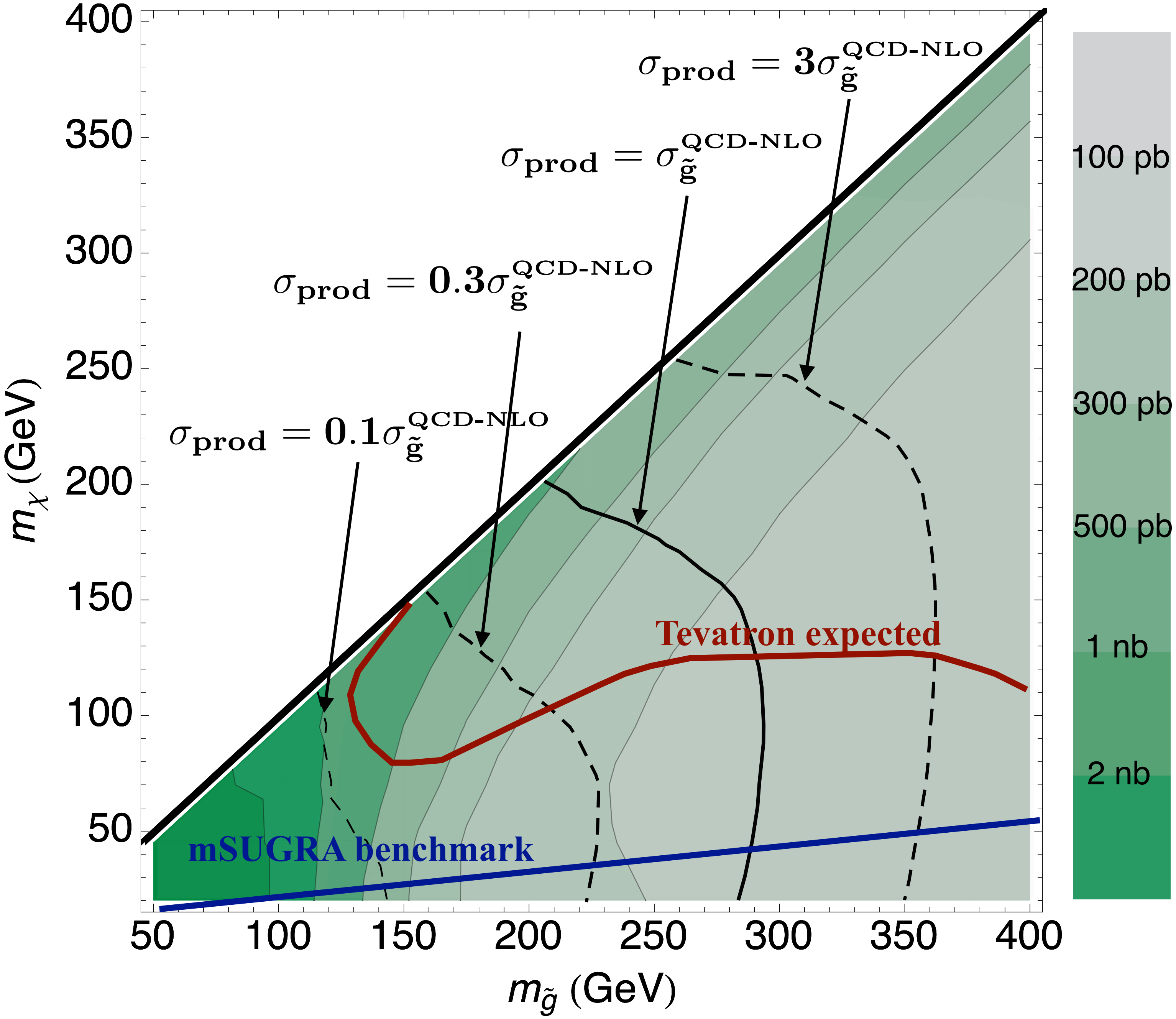


Putting it all together

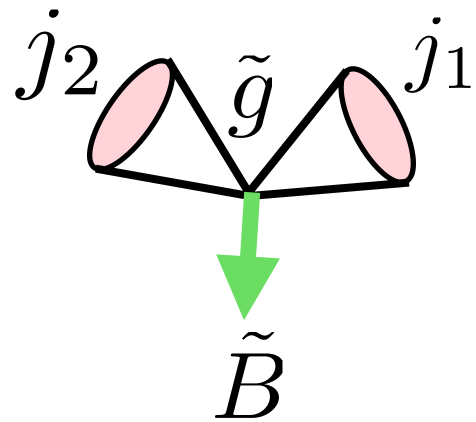
$$\tilde{g} \rightarrow \chi q \bar{q}$$



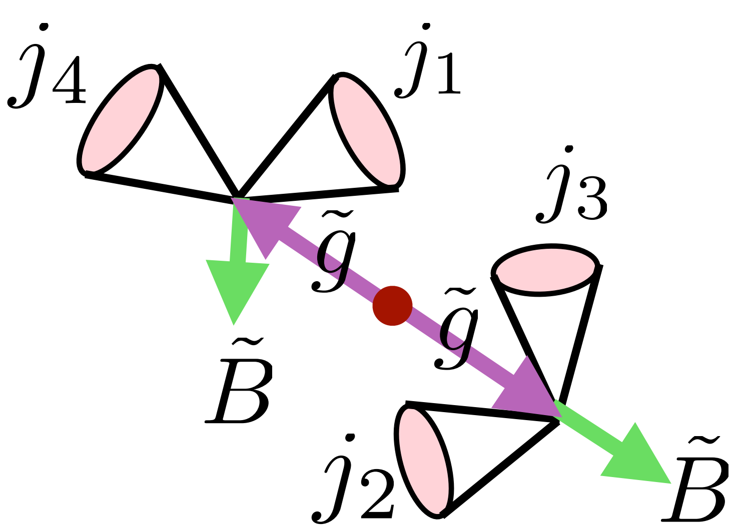
Matching: An Example

150 GeV particle going to 140 GeV LSP and 2 jets

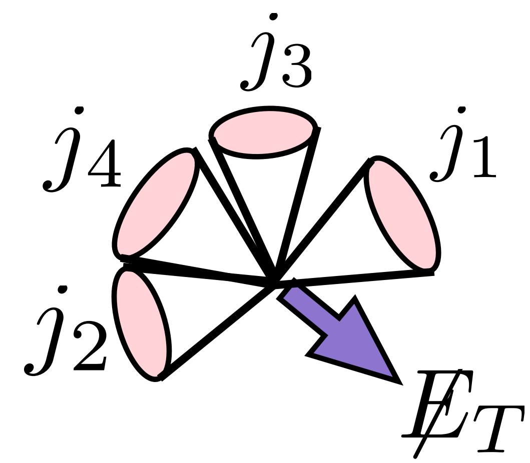
In rest frame of each gluino:
two 3 GeV "jets" and a LSP with 3 GeV momentum



Parton level



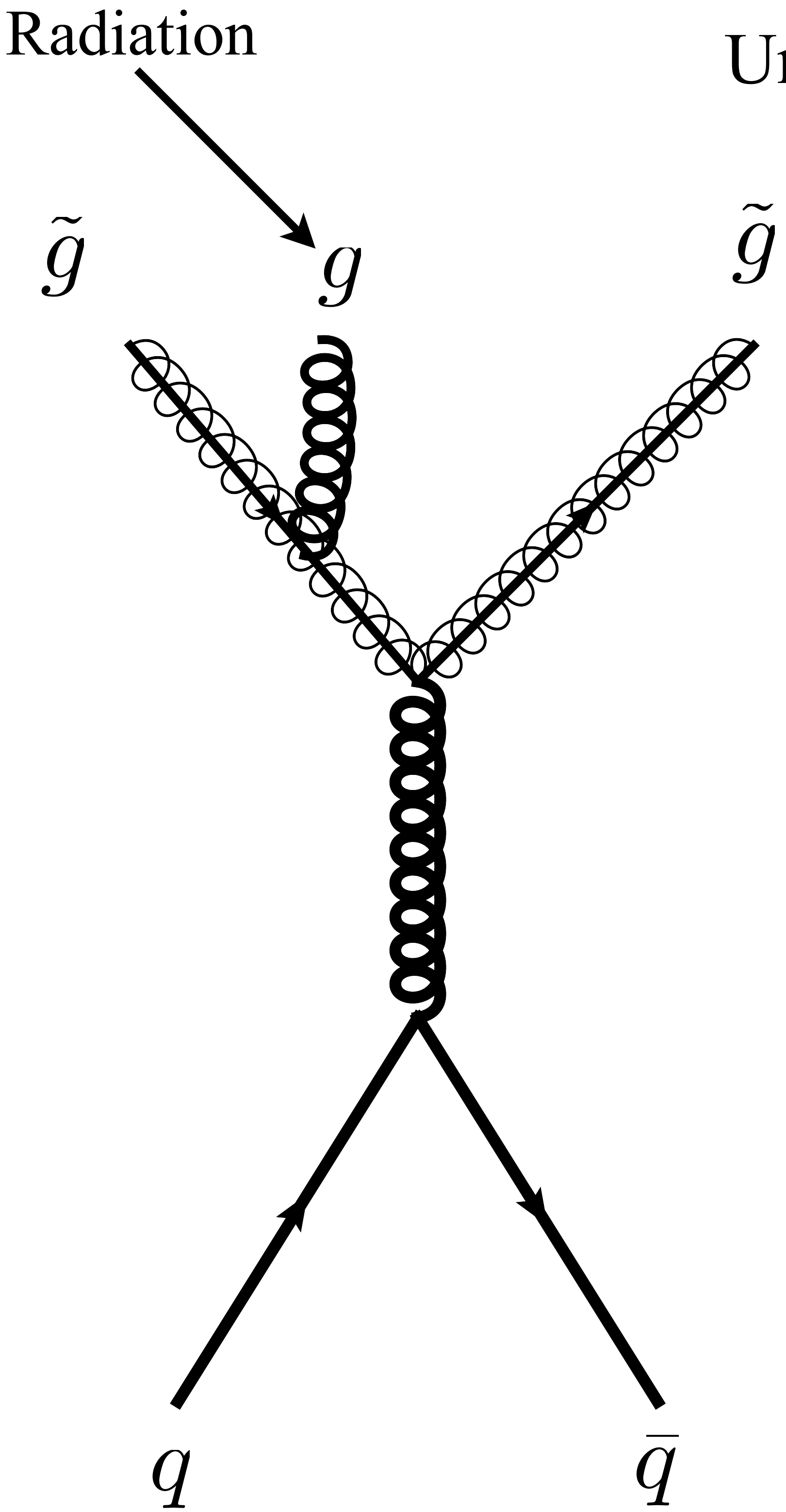
Detector level

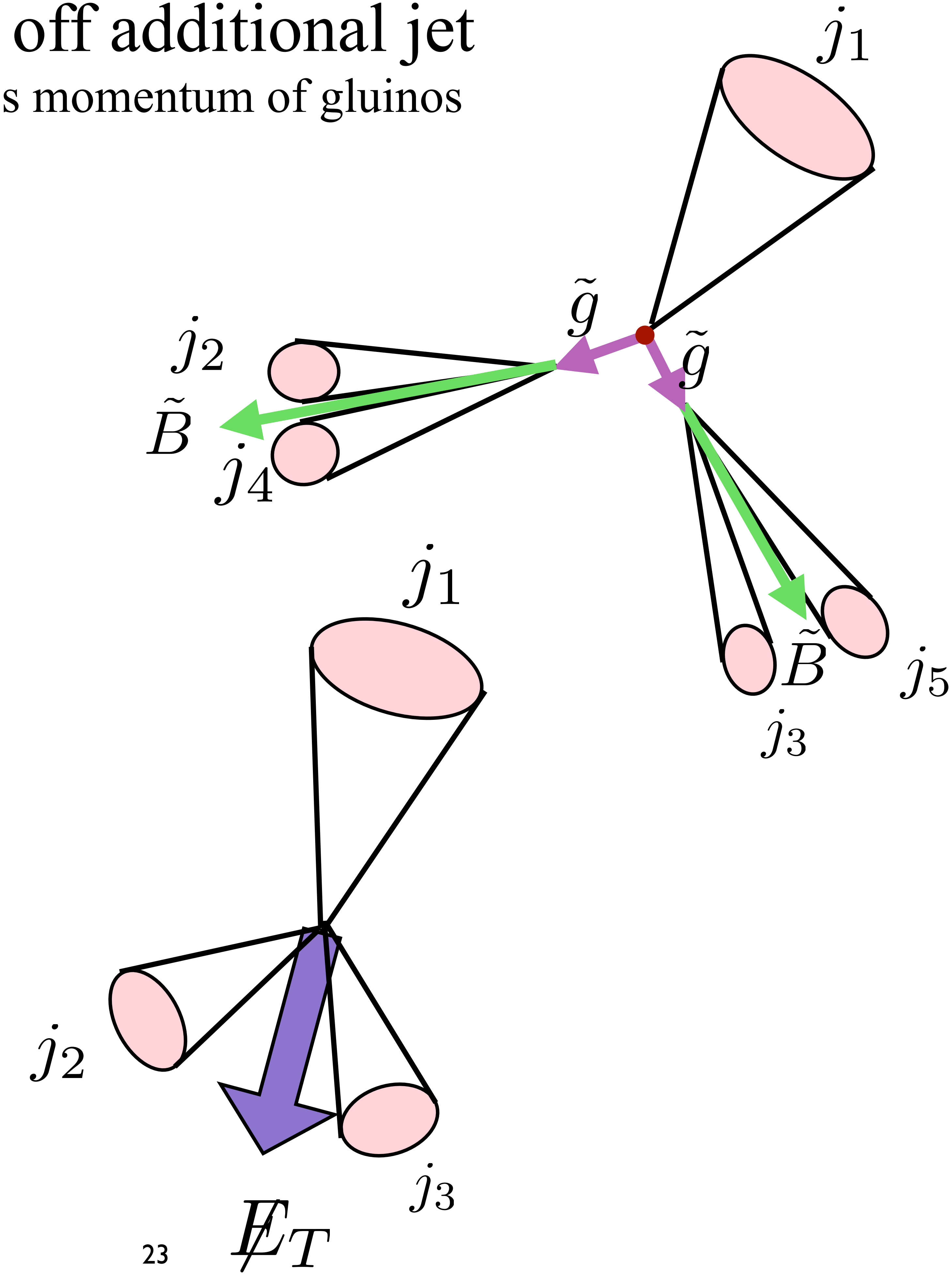


Obscured by QCD with $\sqrt{\hat{s}_{\rm BG}} \sim 20$ GeV

Radiate off additional jet

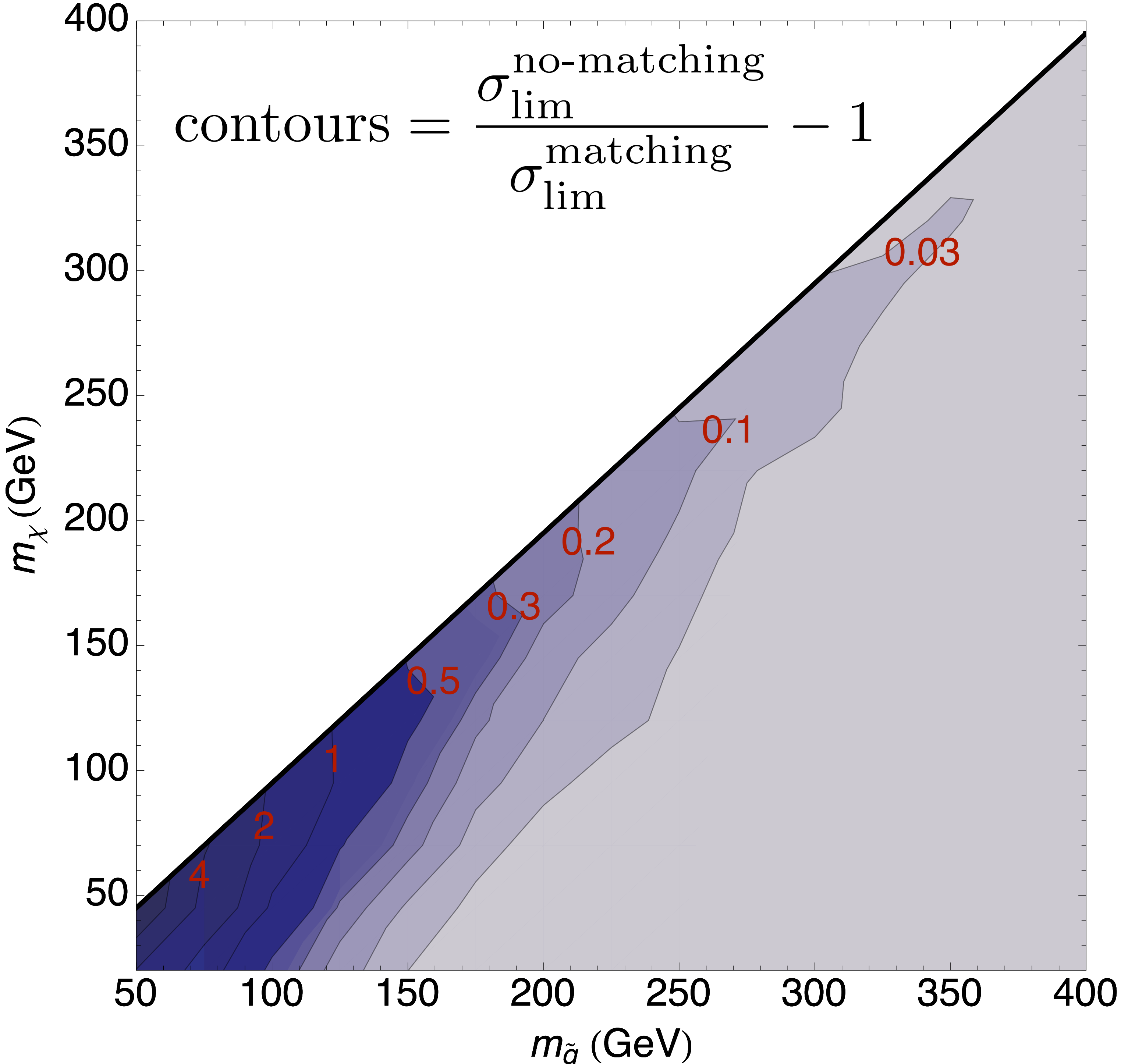
Unbalances momentum of gluinos





Matching

$$\tilde{g} \to \chi q \bar{q}$$



Cascade Decays

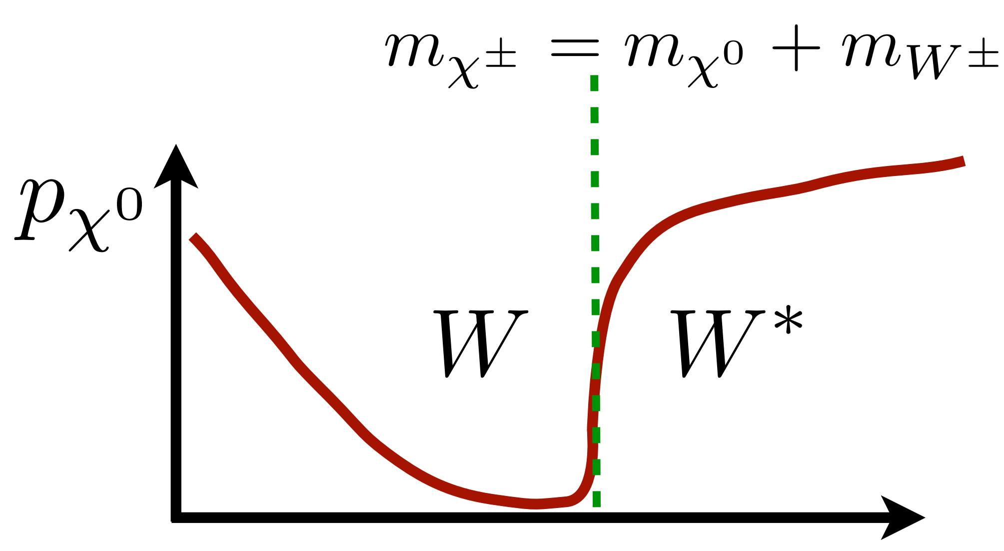
Harder to see these events, lower MET, higher HT

$$\tilde{g} \to q\bar{q}'\chi^{\pm} \to q\bar{q}'\ (\chi^0\ W^{\pm(*)})$$

Chose a slice through the parameter space

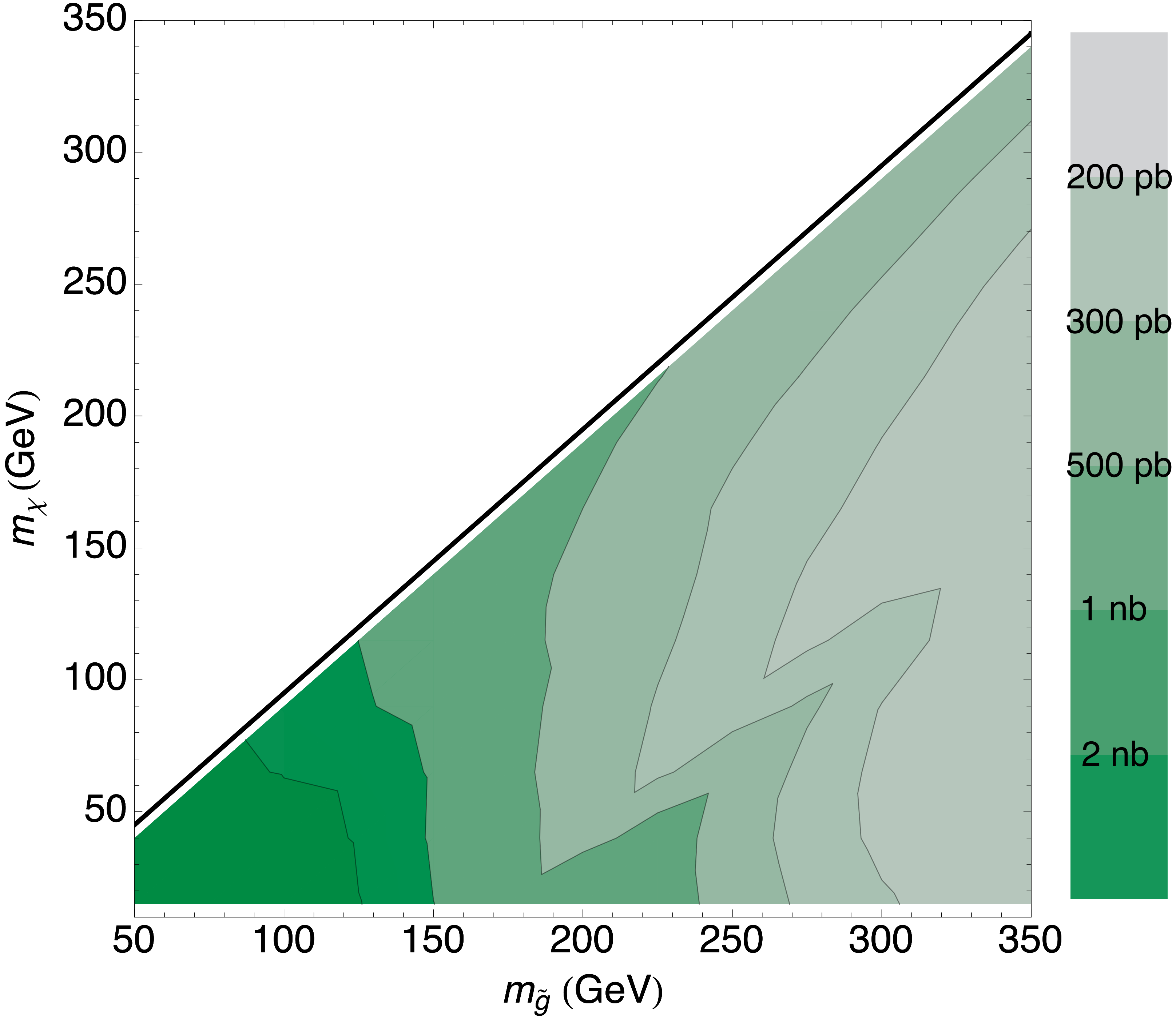
$$m_{\chi^\pm} = \frac{1}{2}(m_{\tilde{g}} + m_{\chi^0})$$

Missing energy changes dramatically between $W^\pm$ vs $W^{\pm *}$



Cascade Decays

$$\widetilde{g} \rightarrow qq'\widetilde{\chi}^{\pm} \rightarrow qq'(W^*\chi^0)$$



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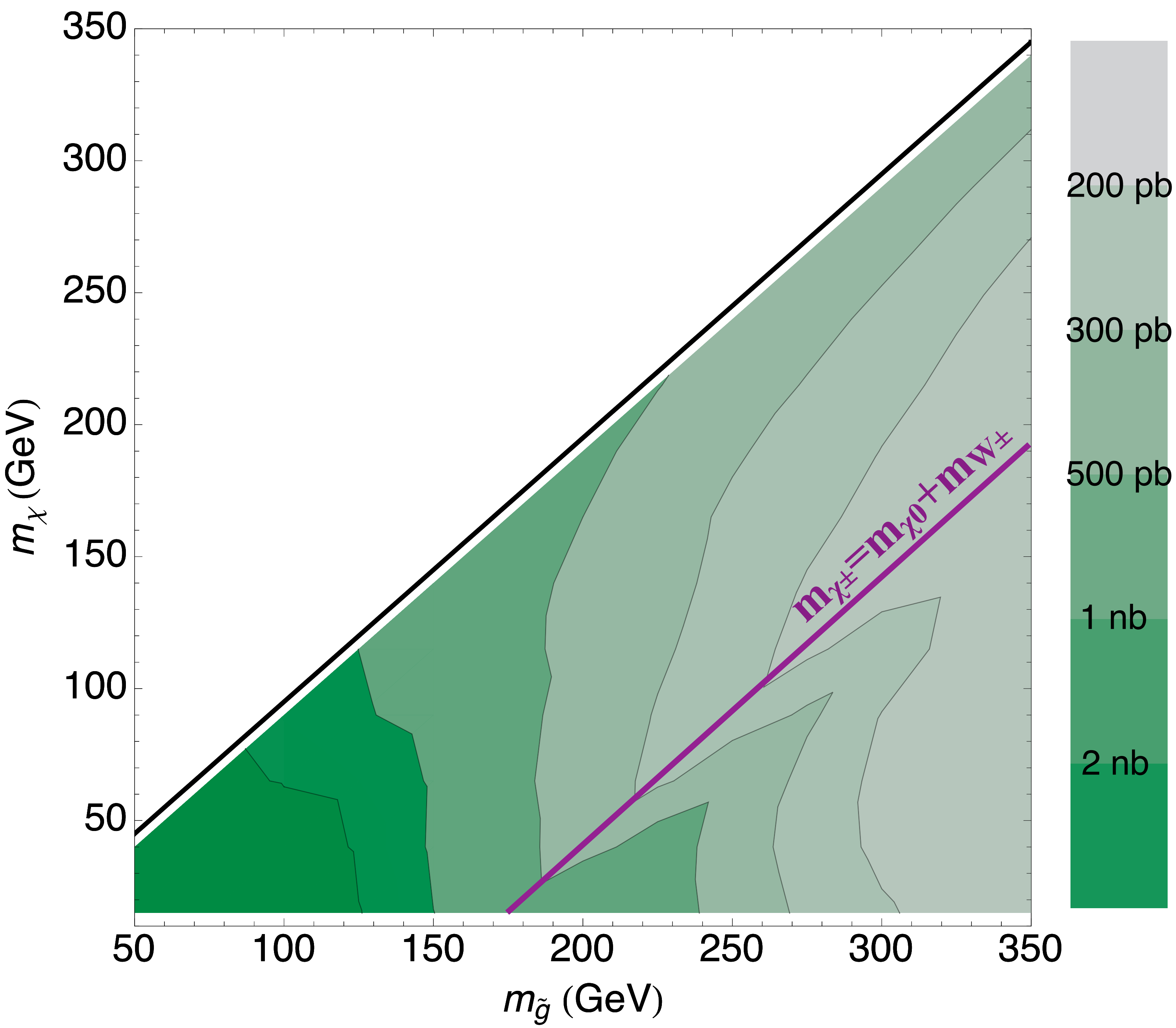

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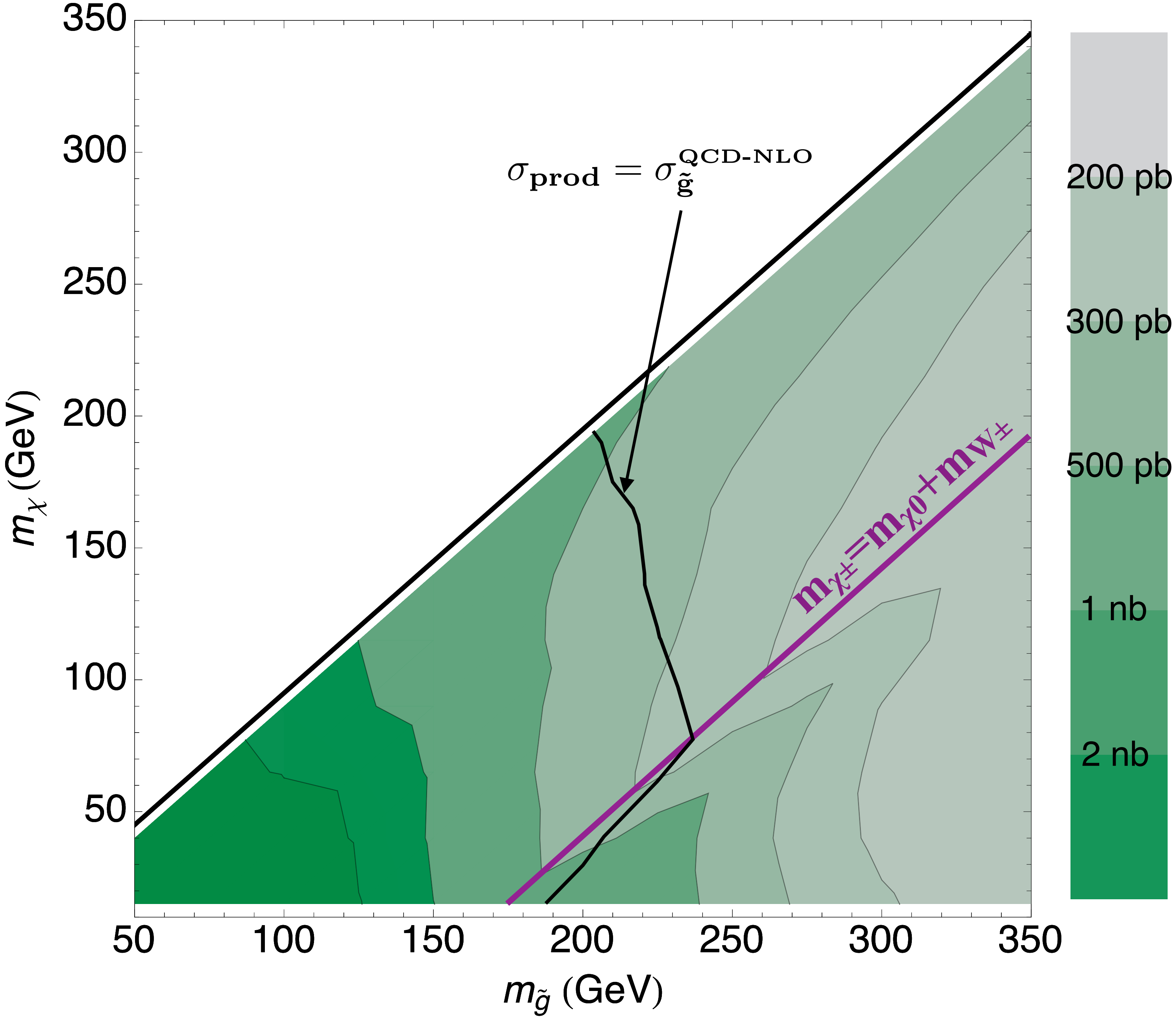

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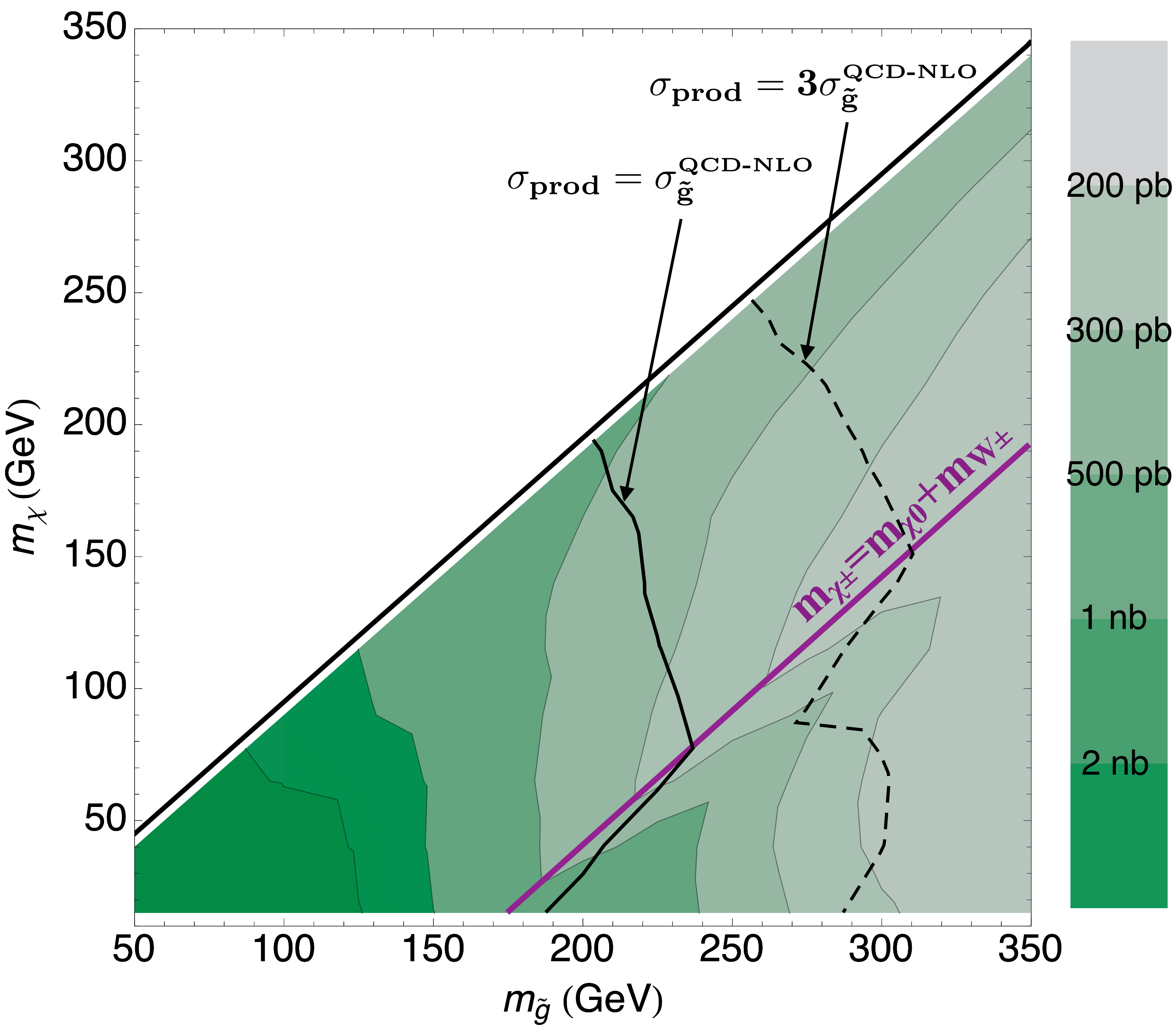
Cascade Decays

$$\tilde{g} \rightarrow qq'\tilde{\chi}^{\pm} \rightarrow qq'(W^{*}\chi^{0})$$



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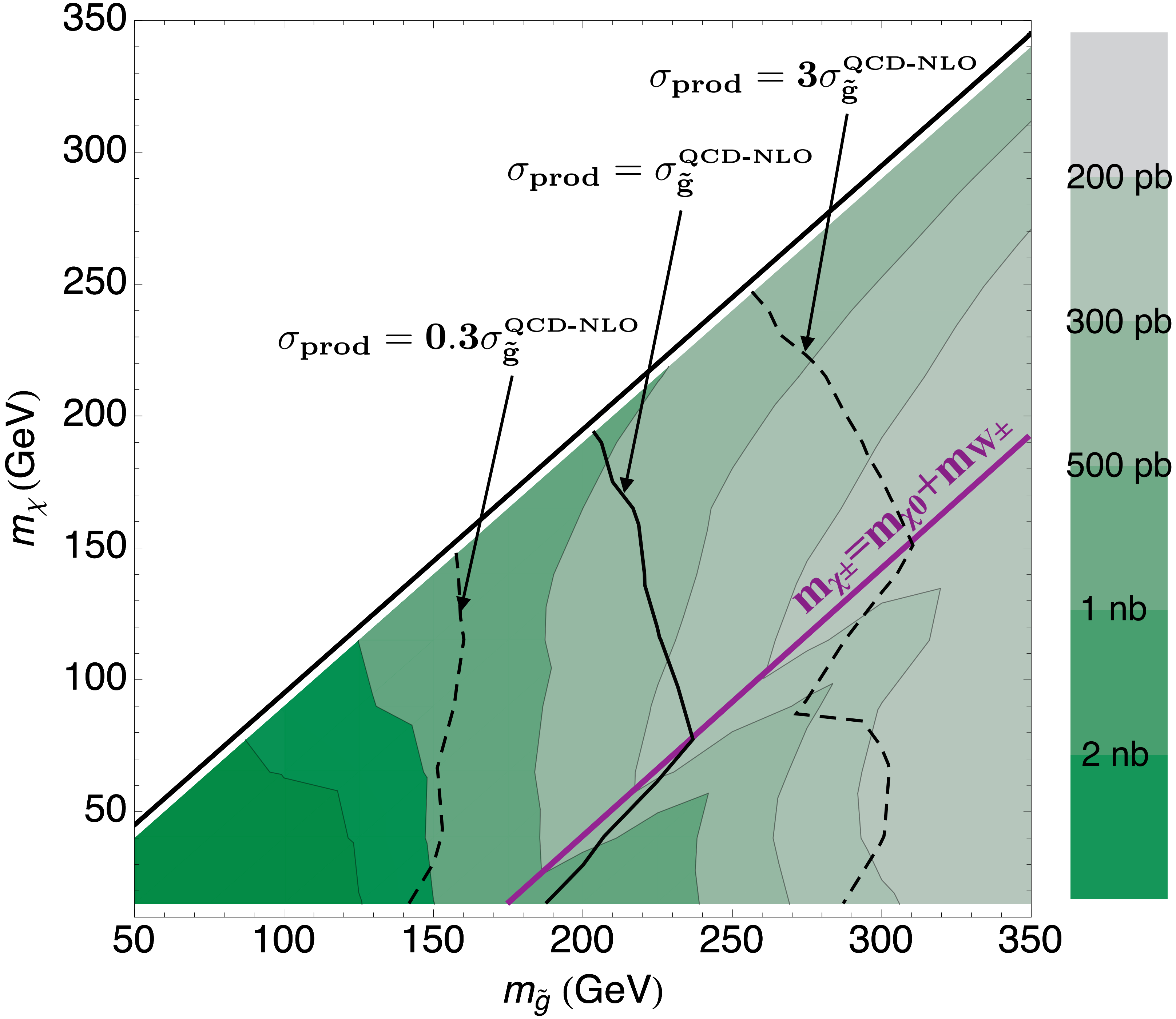
Cascade Decays

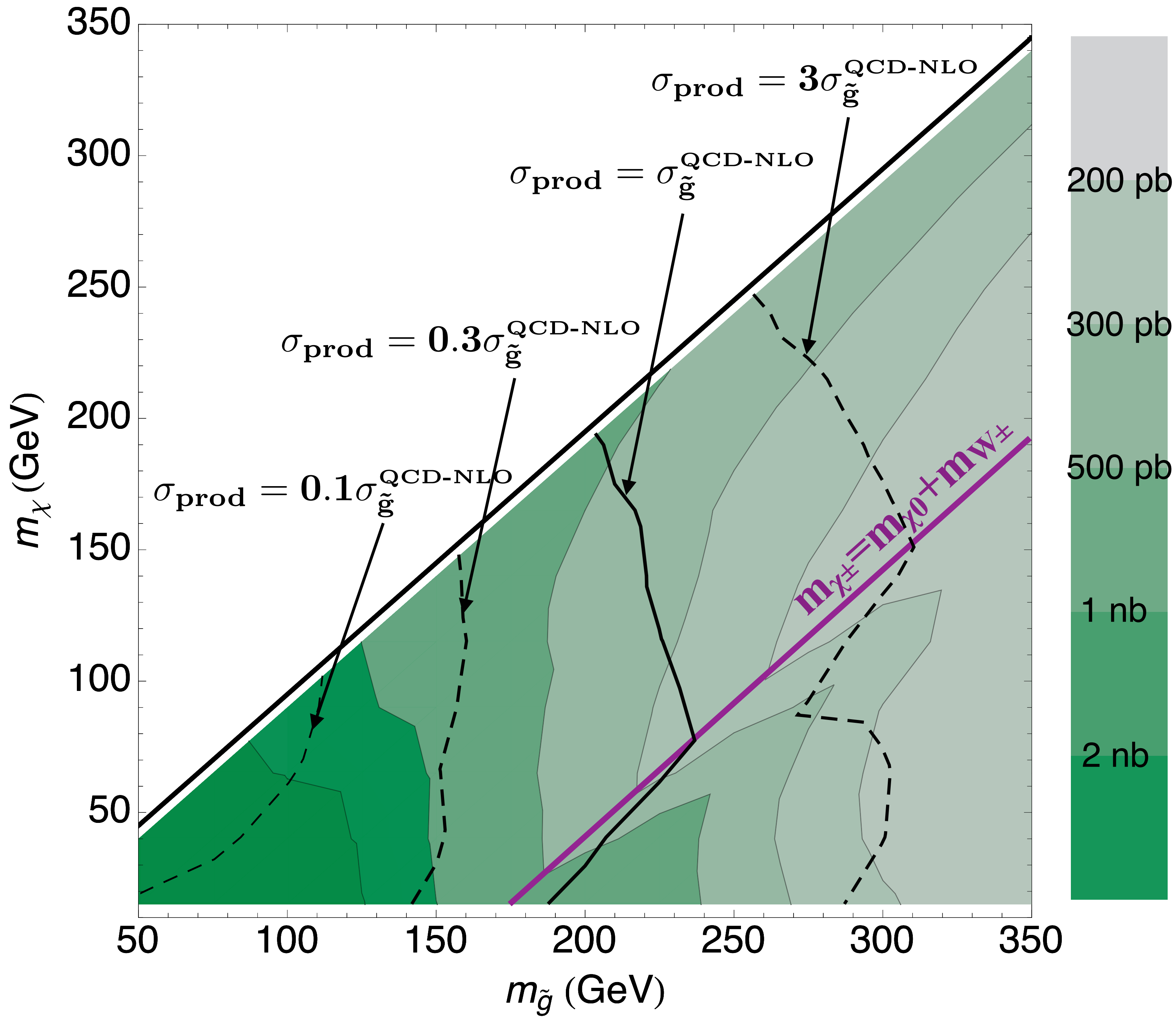
$$\widetilde{g} \to qq'\widetilde{\chi}^{\pm} \to qq'(W^{*}\chi^{0})$$



26

Cascade Decays

$$\widetilde{g} \rightarrow qq'\widetilde{\chi}^{\pm} \rightarrow qq'(W^{*}\chi^{0})$$



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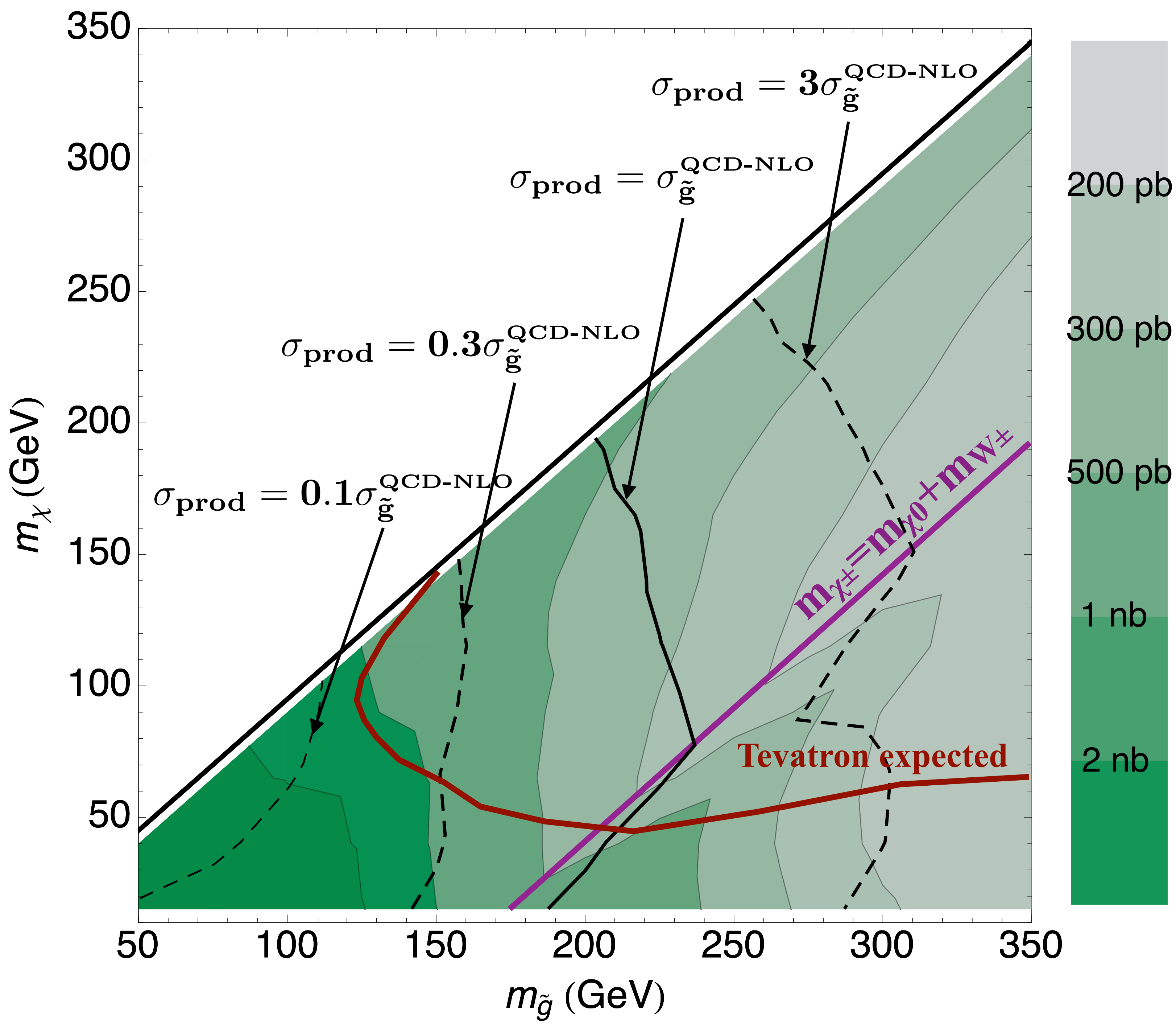
$$\tilde{g} \to qq'\tilde{\chi}^{\pm} \to qq'(W^*\chi^0)$$



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Lessons Learned So Far

ATLAS has accumulated enough data (already!)
to explore previously inaccessible ground

Outline

Simplified Models and Tevatron sensitivity

Early ATLAS results and interpretations

- Prospects for 1 fb^{-1}

Going Forward to 1fb^{-1}

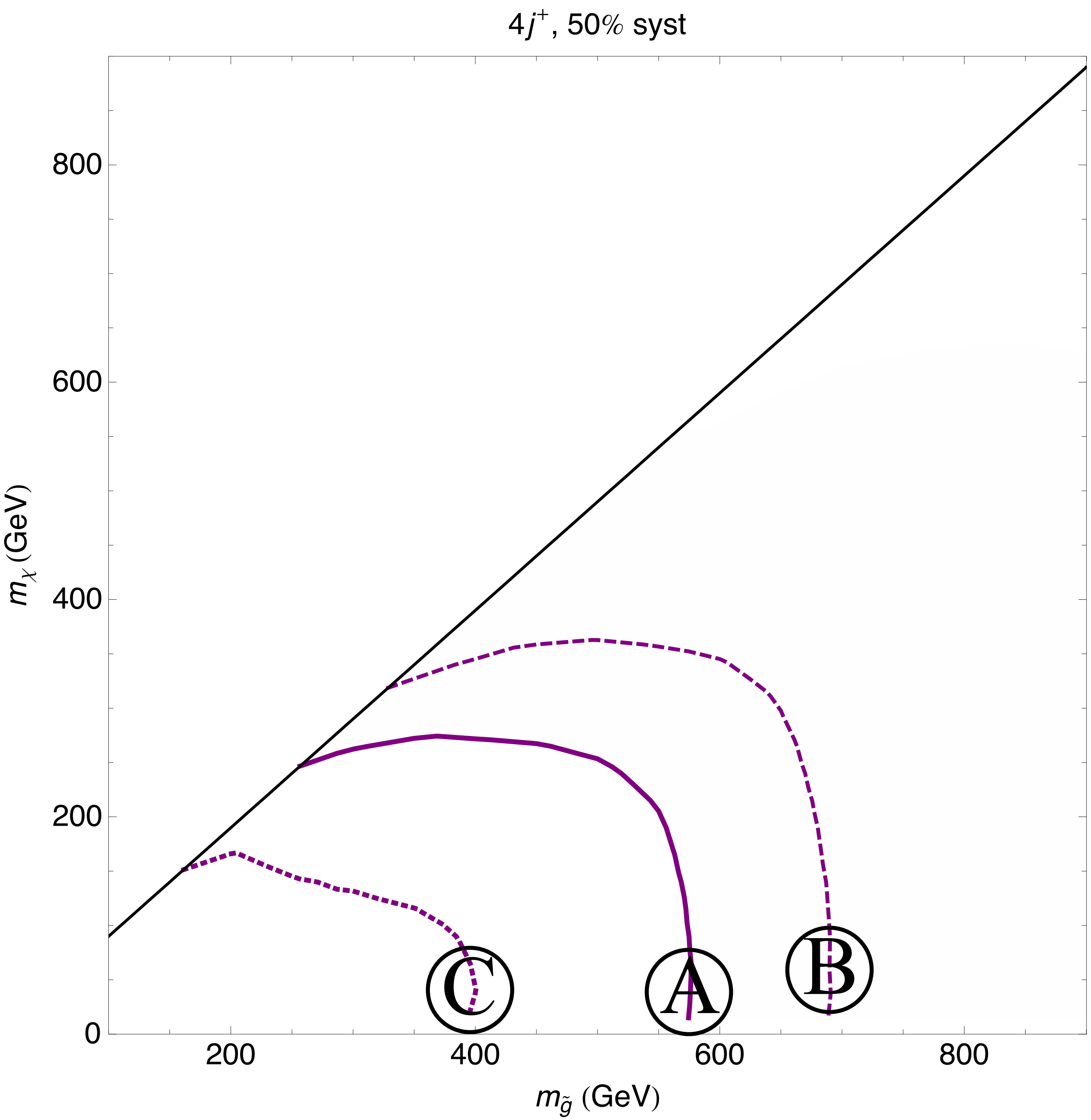
Cut	Topology	$1j + \not\!\!E_T$	$2^+j + \not\!\!E_T$	$3^+j + \not\!\!E_T$	$4^+j + \not\!\!E_T$
1	p_{T1}	$> 100\,\text{GeV}$	$> 100\,\text{GeV}$	$> 100\,\text{GeV}$	$> 100\,\text{GeV}$
2	p_{Tn}	$\leq 50\,\text{GeV}$	$> 50\,\text{GeV}$	$> 50\,\text{GeV}$	$> 50\,\text{GeV}$
3	$\not\!\!E_T$				
4	H_T				
5	$\not\!\!E_T/M_{\text{eff}}$	none	> 0.3	> 0.25	> 0.2

Optimize cuts H_T $\not\!\!E_T$

for simplified models

Direct Decays Sensitivity

$$\tilde{g} \to \chi q \bar{q}$$



$$\not{E}_T > 200 \text{ GeV}$$

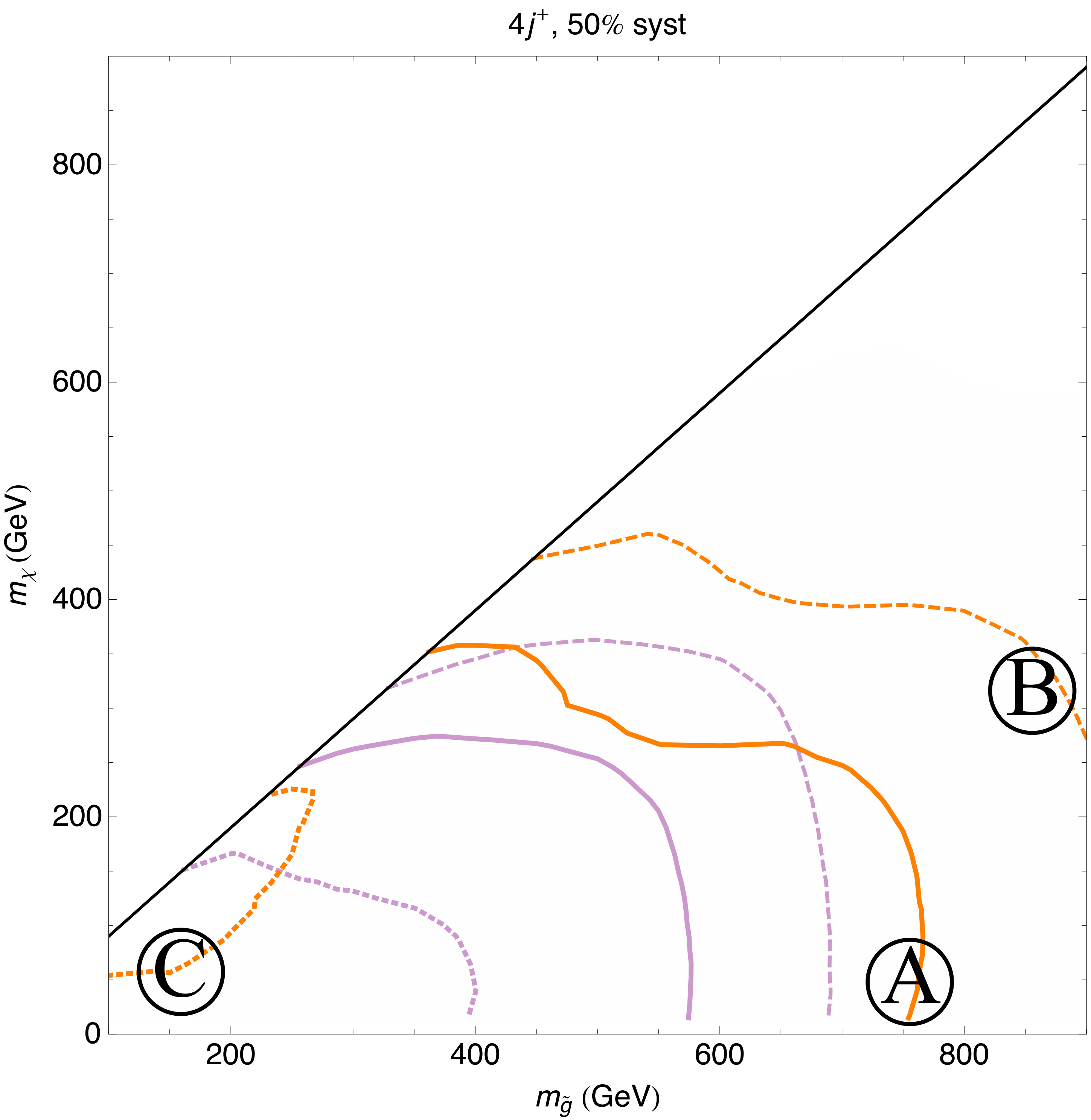
Ⓐ $\sigma_{\rm prod} \times \mathcal{B} = \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓑ $\sigma_{\rm prod} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓒ $\sigma_{\rm prod} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Direct Decays Sensitivity

$$\tilde{g} \to \chi q \bar{q}$$



$\not{E}_T > 200$ GeV

$\not{E}_T > 400$ GeV

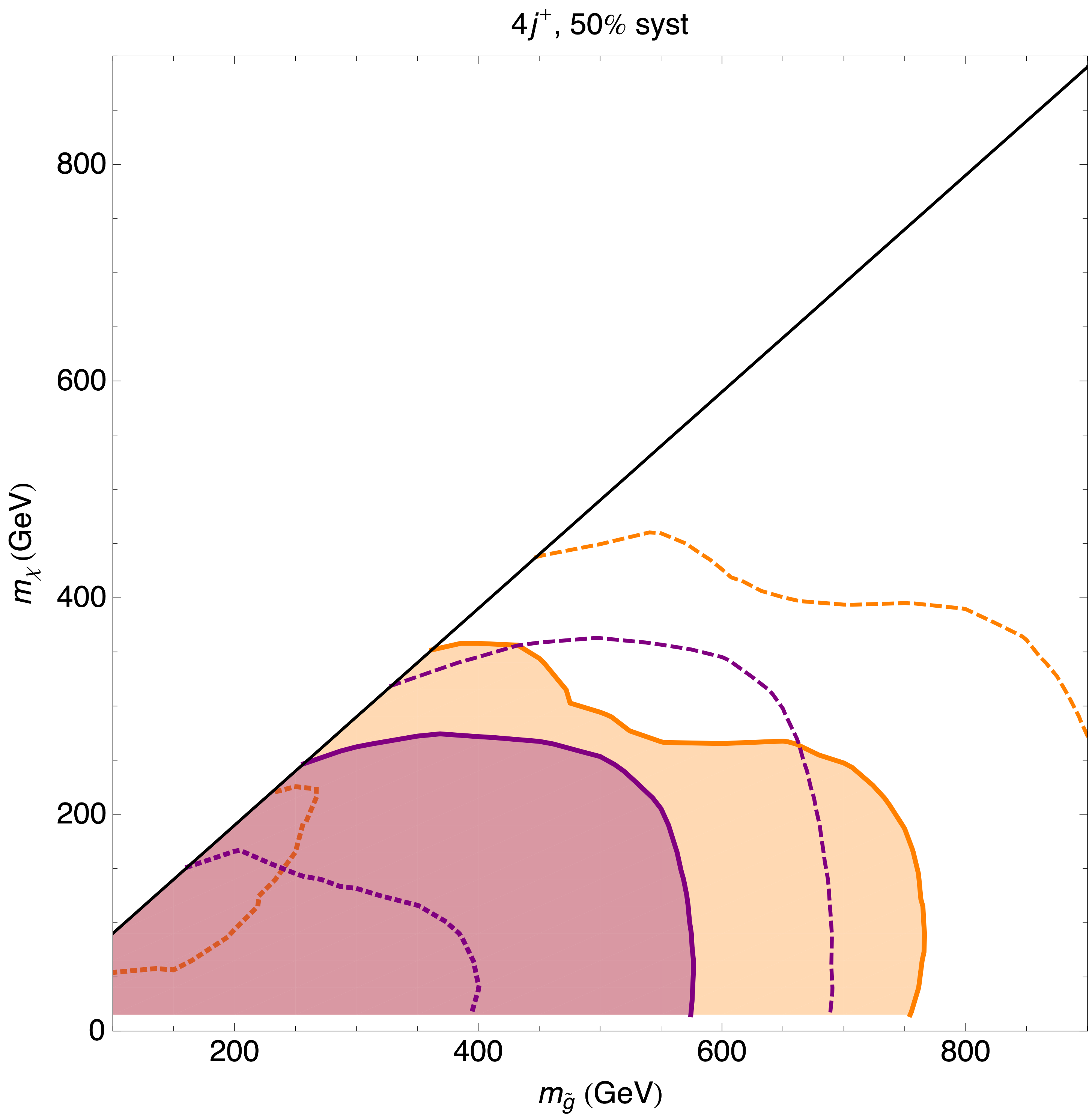
Ⓐ $\sigma_{\rm prod} \times \mathcal{B} = \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓑ $\sigma_{\rm prod} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓒ $\sigma_{\rm prod} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Direct Decays Sensitivity

$$\tilde{g} \to \chi q \bar{q}$$



$\not{E}_T > 200$ GeV

$\not{E}_T > 400$ GeV

Ⓐ $\sigma_{\rm prod} \times \mathcal{B} = \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

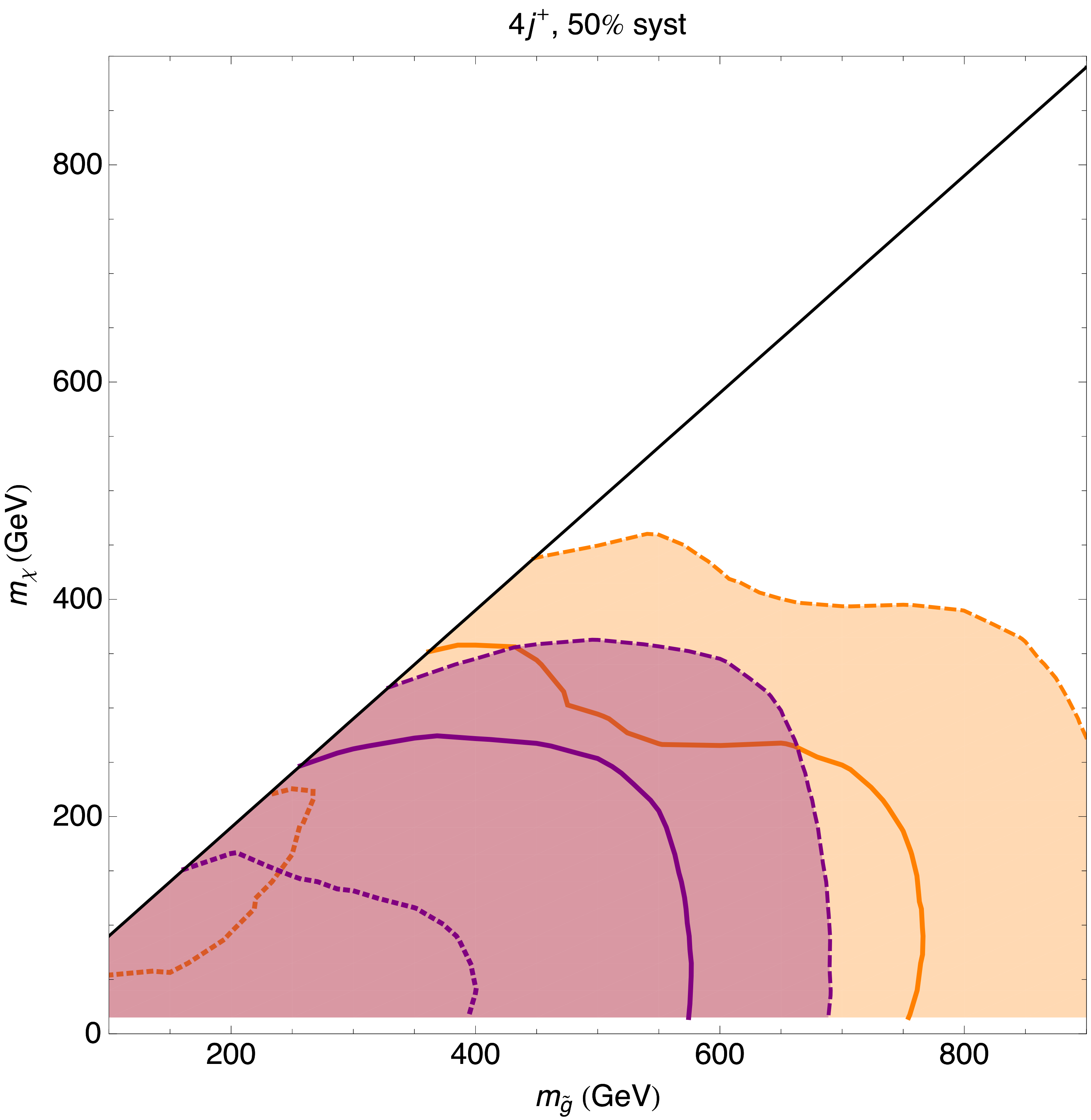
Ⓑ $\sigma_{\rm prod} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓒ $\sigma_{\rm prod} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

X

Direct Decays Sensitivity

$$\tilde{g} \to \chi q \bar{q}$$



$\not{E}_T > 200$ GeV

$\not{E}_T > 400$ GeV

Ⓐ $\sigma_{\rm prod} \times \mathcal{B} = \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

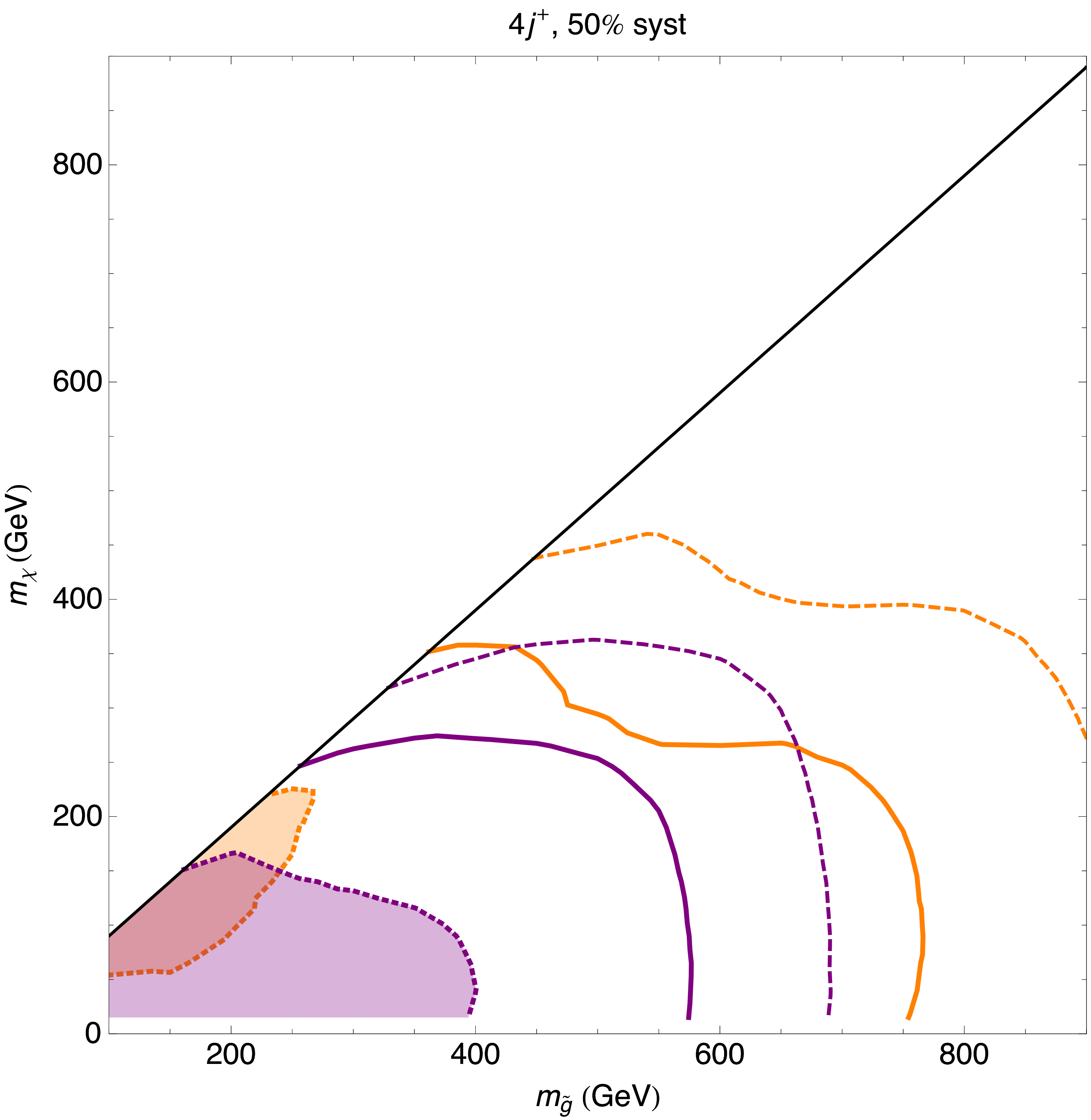
Ⓑ $\sigma_{\rm prod} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓒ $\sigma_{\rm prod} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

x

Direct Decays Sensitivity

$$\tilde{g} \to \chi q \bar{q}$$



$\not{E}_T > 200$ GeV

$\not{E}_T > 400$ GeV

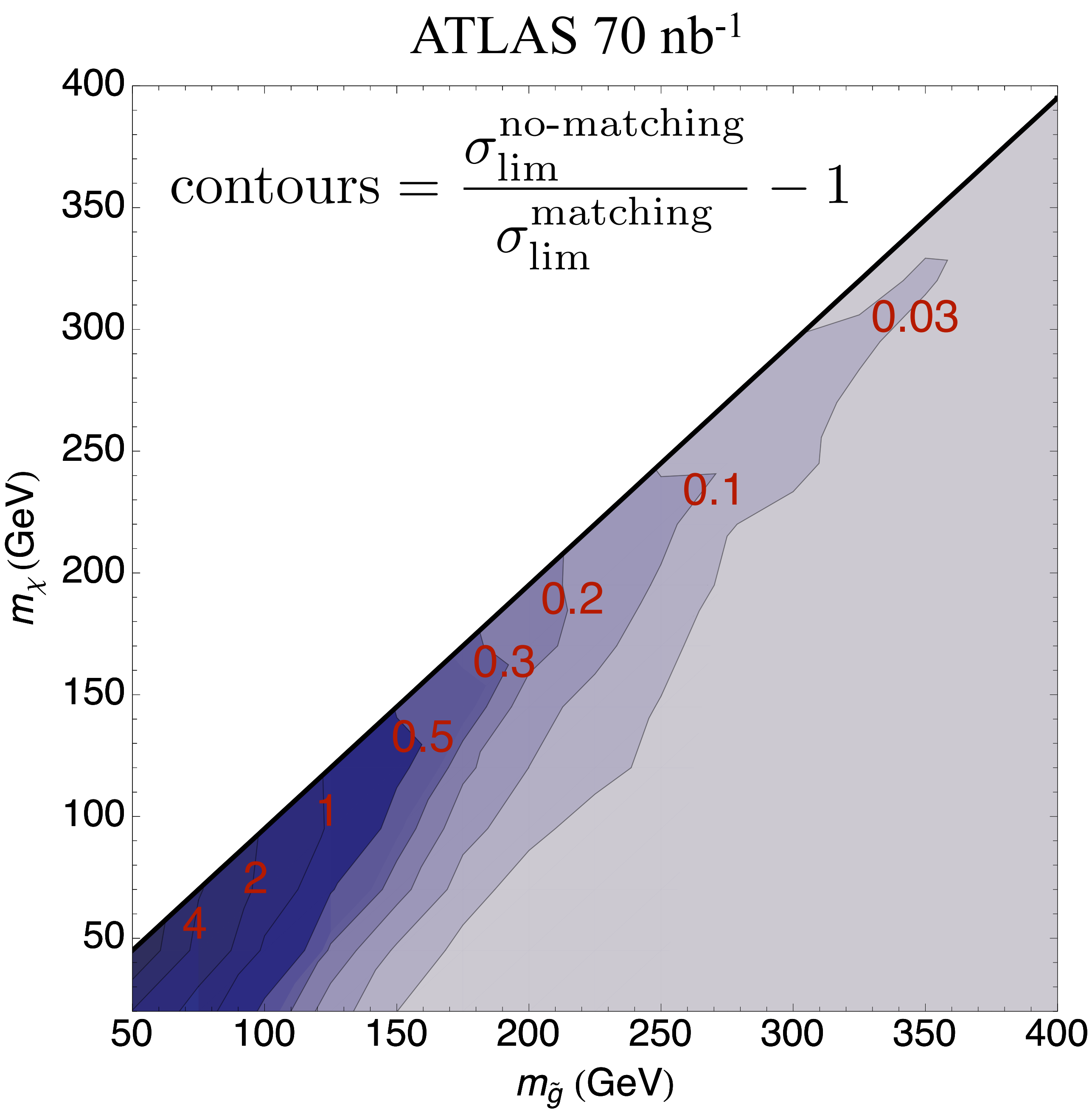
(A) $\sigma_{\text{prod}} \times \mathcal{B} = \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

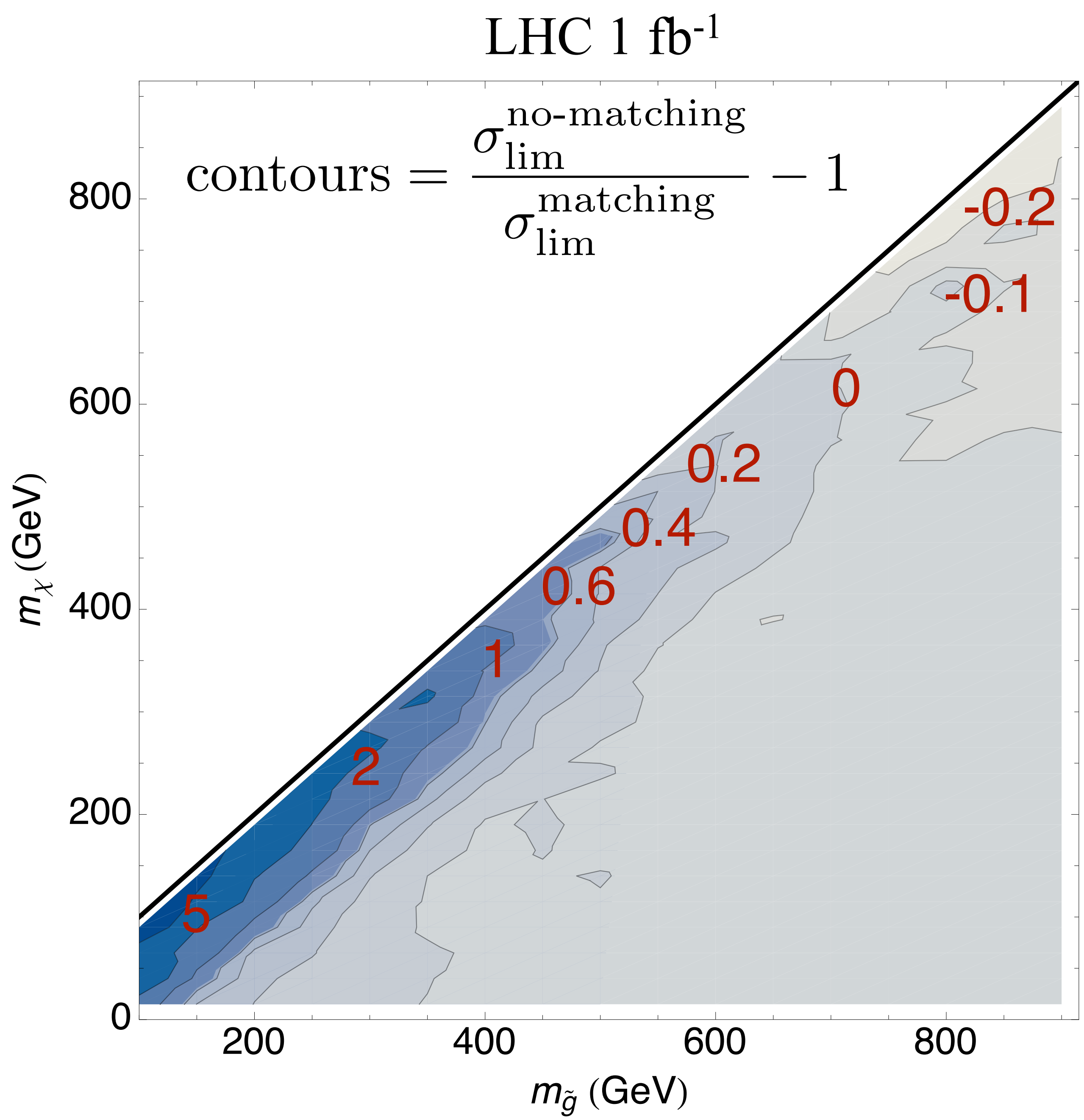
(B) $\sigma_{\text{prod}} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

(C) $\sigma_{\text{prod}} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

x

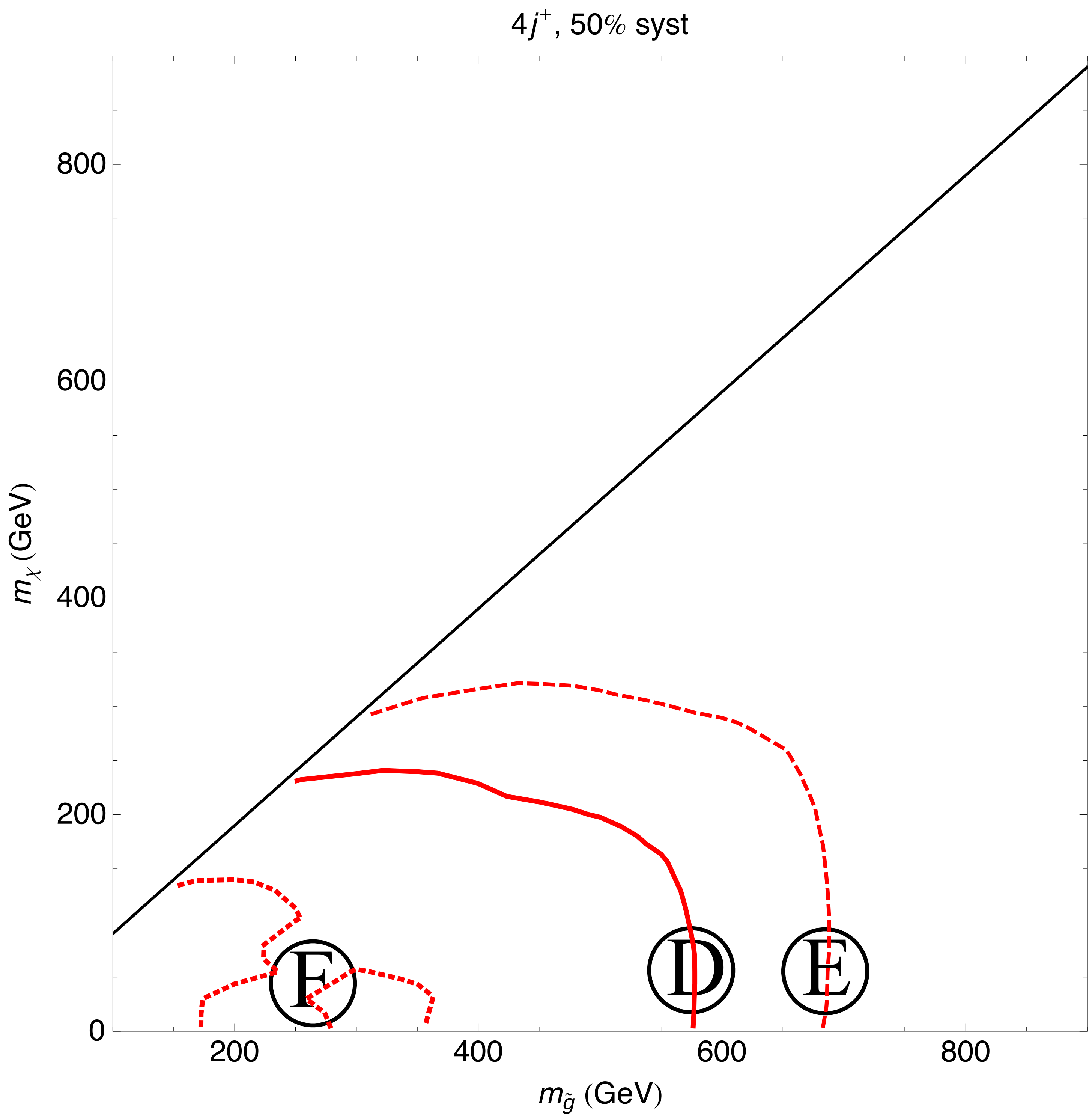
Matching (Revisited)





Cascade Decays

$$\tilde{g} \to q q' \tilde{\chi}^{\pm} \to q q' (W^* \chi^0)$$



$$\frac{\not{E}_T}{M_{\rm eff}} > 0.2$$

$$\not{E}_T > 100 \text{ GeV}$$
$$H_T > 600 \text{ GeV}$$

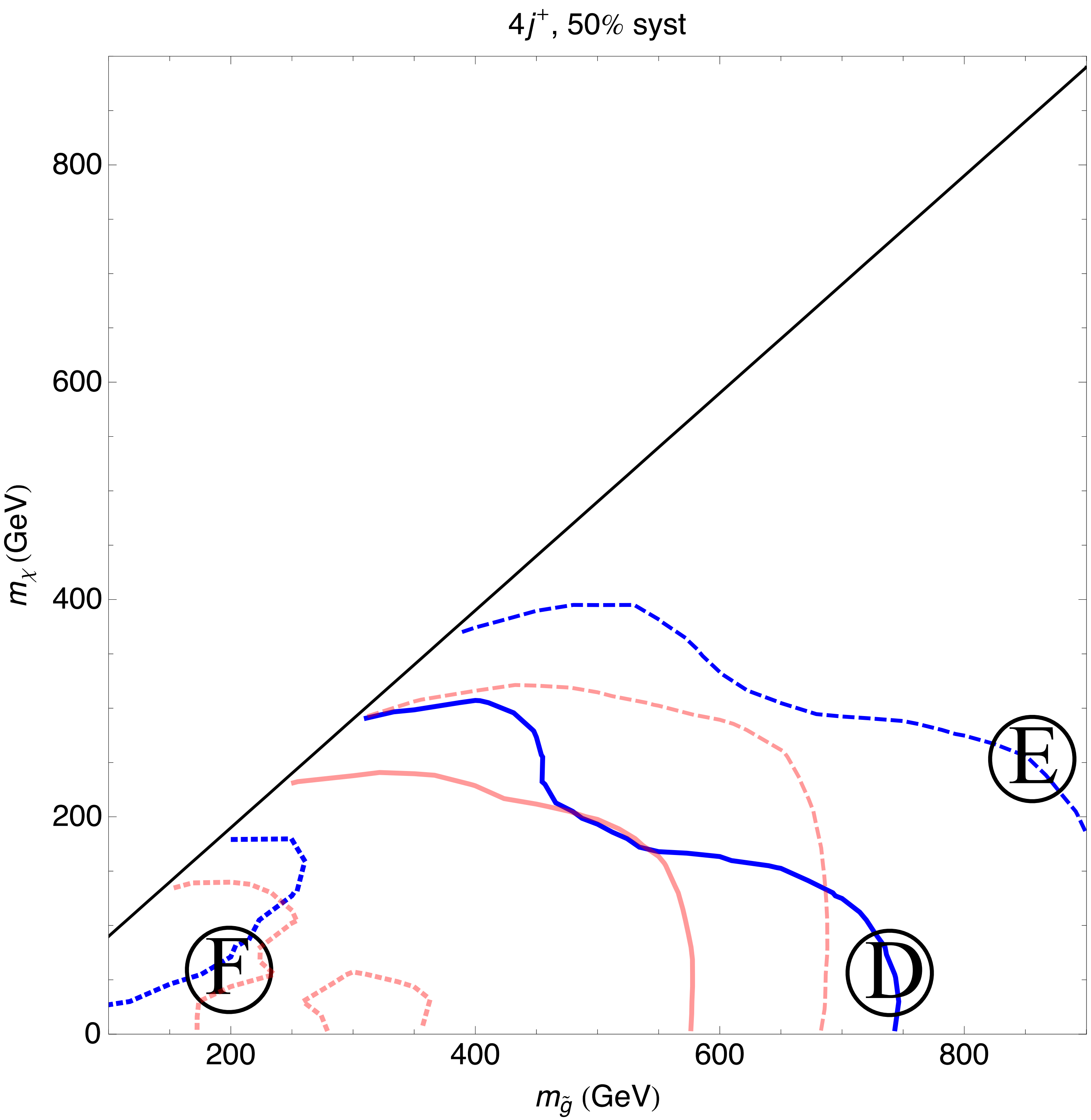
Ⓓ $\sigma_{\rm prod} \times \mathcal{B} = \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓔ $\sigma_{\rm prod} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Ⓕ $\sigma_{\rm prod} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

Cascade Decays

$$\widetilde{g} \to qq'\widetilde{\chi}^{\pm} \to qq'(W^*\chi^0)$$



$$\frac{\not{E}_T}{M_{\rm eff}} > 0.2$$

$\not{E}_T > 100$ GeV
$H_T > 600$ GeV

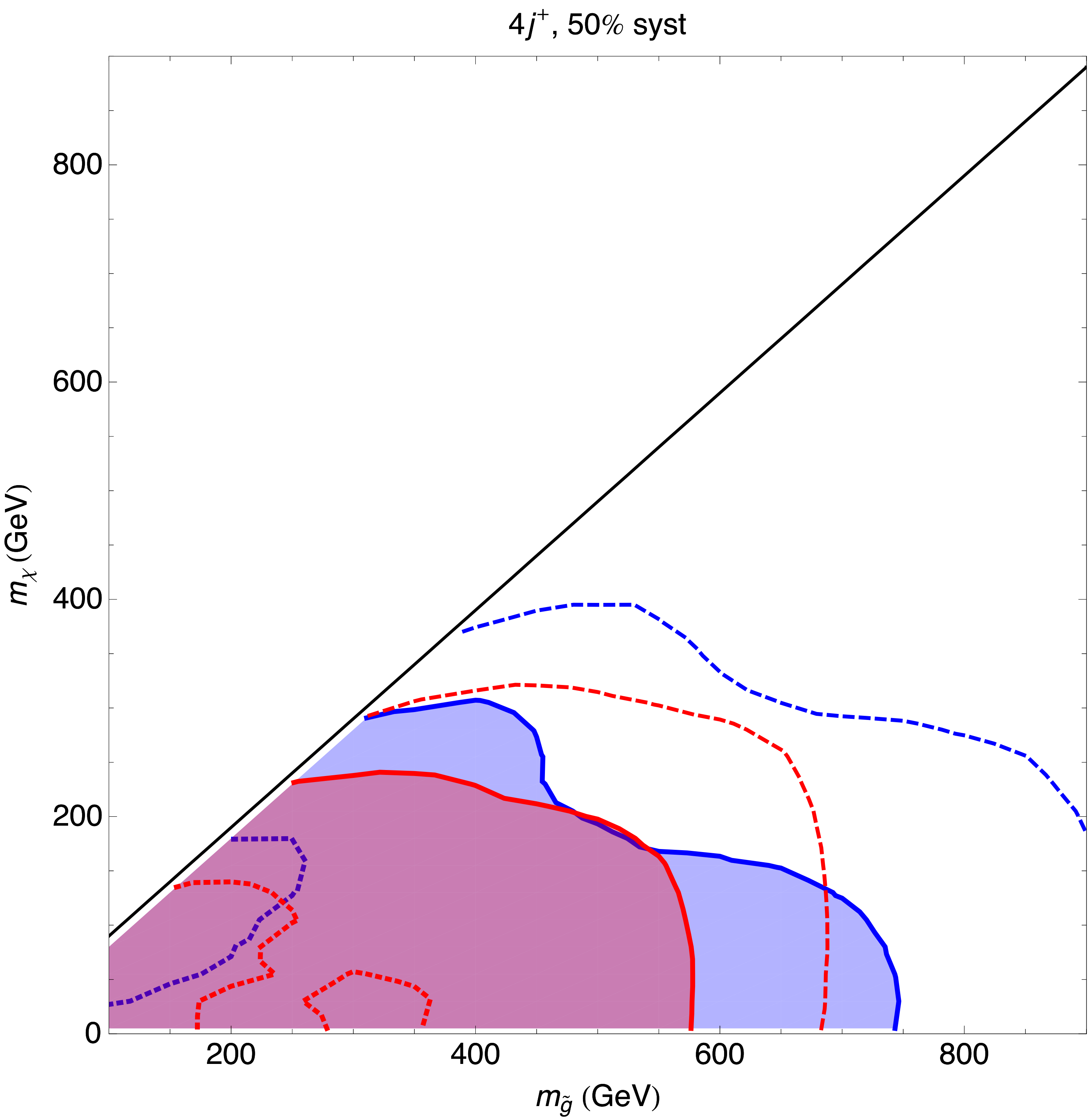
$\not{E}_T > 300$ GeV
$H_T > 900$ GeV

(D) $\sigma_{\rm prod} \times \mathcal{B} = \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

(E) $\sigma_{\rm prod} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

(F) $\sigma_{\rm prod} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\rm QCD\text{-}NLO}$

One-Step Cascade Decay



$$\frac{\not{E}_T}{M_{\text{eff}}} > 0.2$$

$\not{E}_T > 100$ GeV
$H_T > 600$ GeV

$\not{E}_T > 300$ GeV
$H_T > 900$ GeV

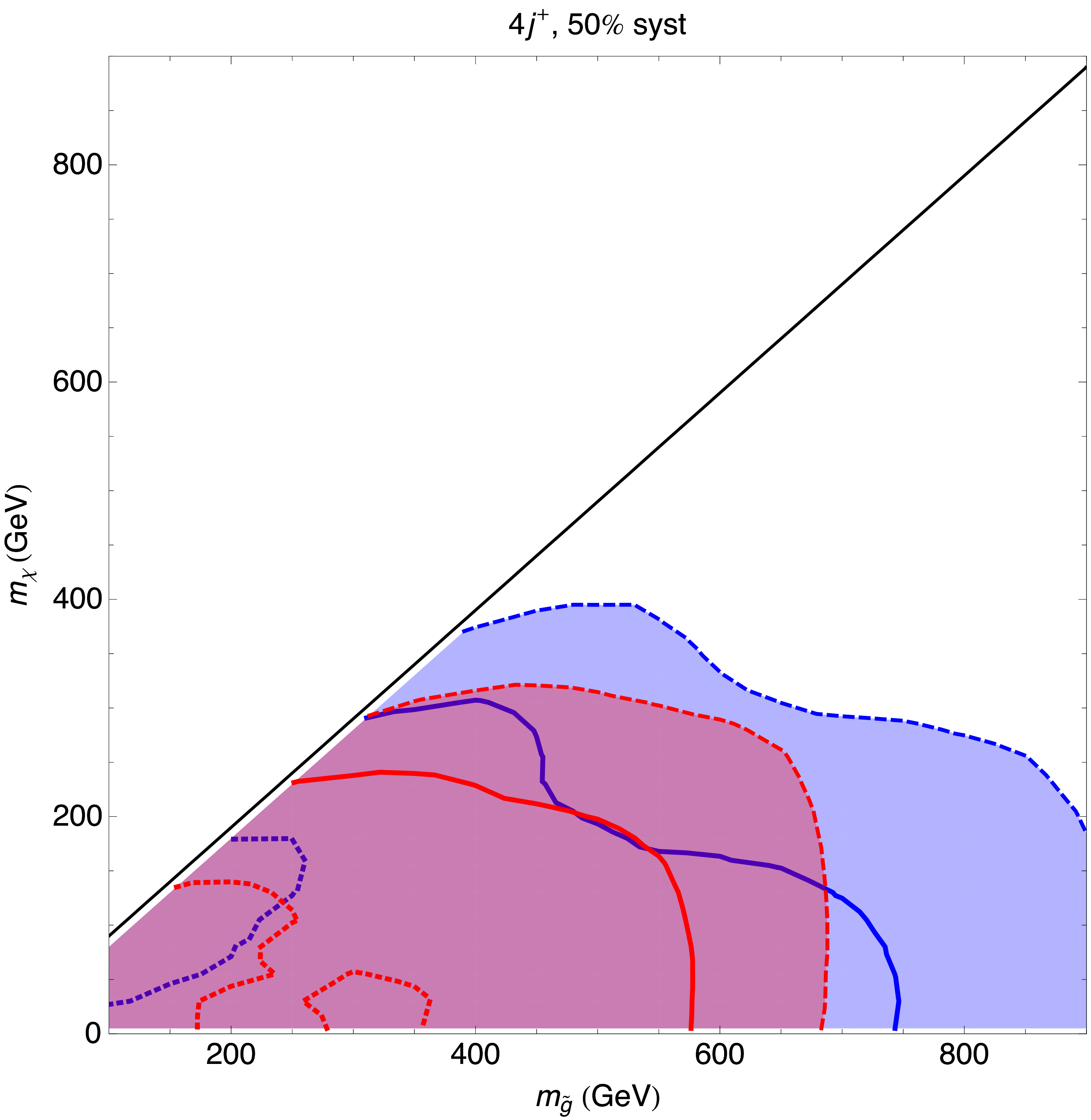
Ⓓ $\sigma_{\text{prod}} \times \mathcal{B} = \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

Ⓔ $\sigma_{\text{prod}} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

Ⓕ $\sigma_{\text{prod}} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

X

One-Step Cascade Decay



$$\frac{\not{E}_T}{M_{\text{eff}}} > 0.2$$

$$\not{E}_T > 100 \text{ GeV}$$
$$H_T > 600 \text{ GeV}$$

$$\not{E}_T > 300 \text{ GeV}$$
$$H_T > 900 \text{ GeV}$$

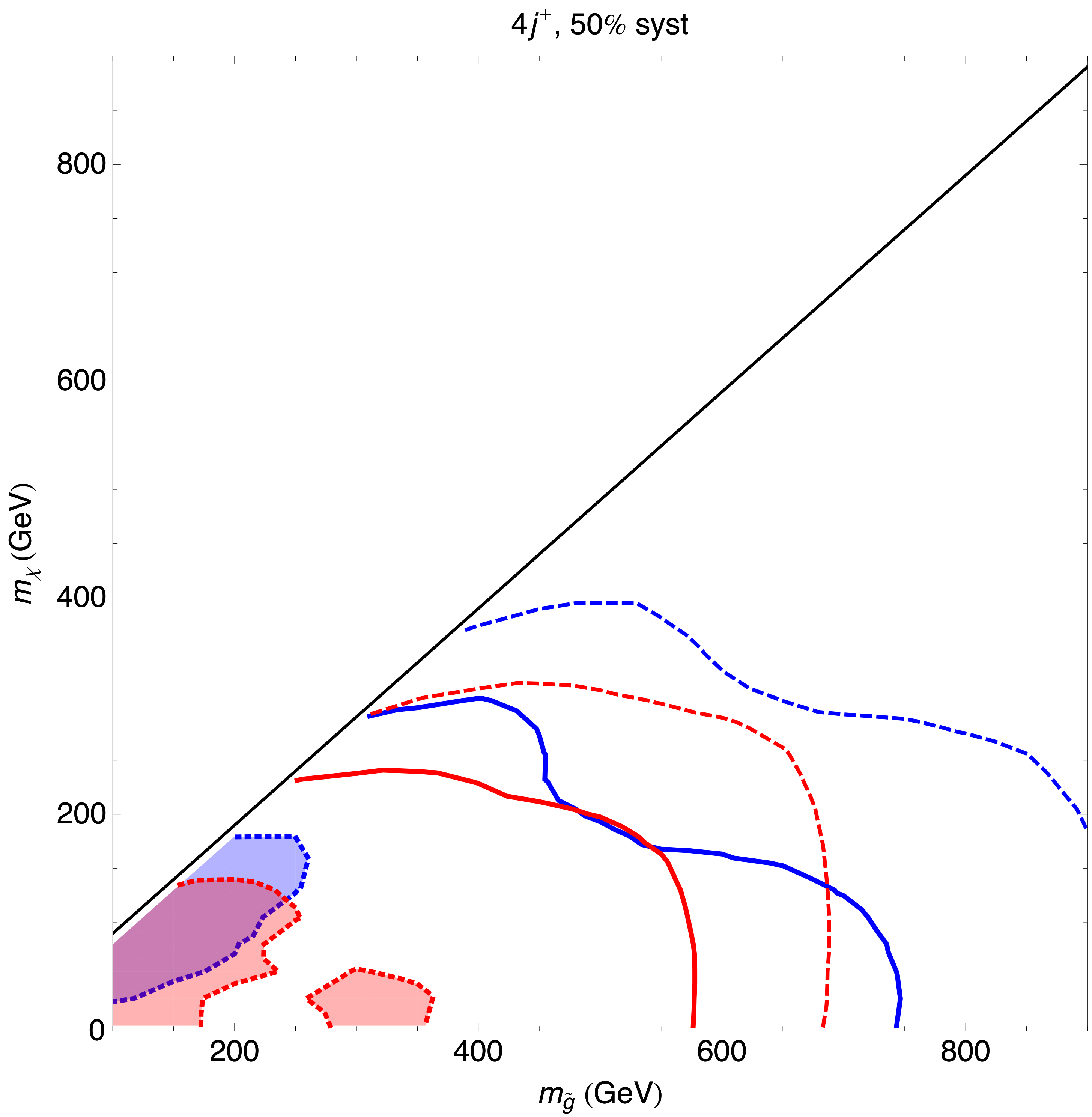
Ⓓ $\sigma_{\text{prod}} \times \mathcal{B} = \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

Ⓔ $\sigma_{\text{prod}} \times \mathcal{B} = 3\ \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

Ⓕ $\sigma_{\text{prod}} \times \mathcal{B} = 0.2\ \sigma_{\tilde{g}}^{\text{QCD-NLO}}$

X

One-Step Cascade Decay



$$\frac{\not{E}_T}{M_{\text{eff}}} > 0.2$$

$\not{E}_T > 100$ GeV
$H_T > 600$ GeV

$\not{E}_T > 300$ GeV
$H_T > 900$ GeV

Ⓓ $\sigma_{\text{prod}} \times \mathcal{B} = \sigma_{\tilde g}^{\text{QCD-NLO}}$

Ⓔ $\sigma_{\text{prod}} \times \mathcal{B} = 3\ \sigma_{\tilde g}^{\text{QCD-NLO}}$

Ⓕ $\sigma_{\text{prod}} \times \mathcal{B} = 0.2\ \sigma_{\tilde g}^{\text{QCD-NLO}}$

X

Lessons Learned

There is a lot of ground the Tevatron could have covered, had it stepped away from benchmarks

At such an early stage
ATLAS capable of reaching uncharted territory

Looking ahead to next year
good reasons to be optimistic

Future Work

Multiple Cascade Decays

Can further reduce MET and increase HT

How bad is it and how to recover reach

b-tagging & anti-b-tagging

Heavy flavor can appear in final states

Top is a big background at moderate MET,
w/o heavy flavor final states, anti-b-tagging may help

Thank You

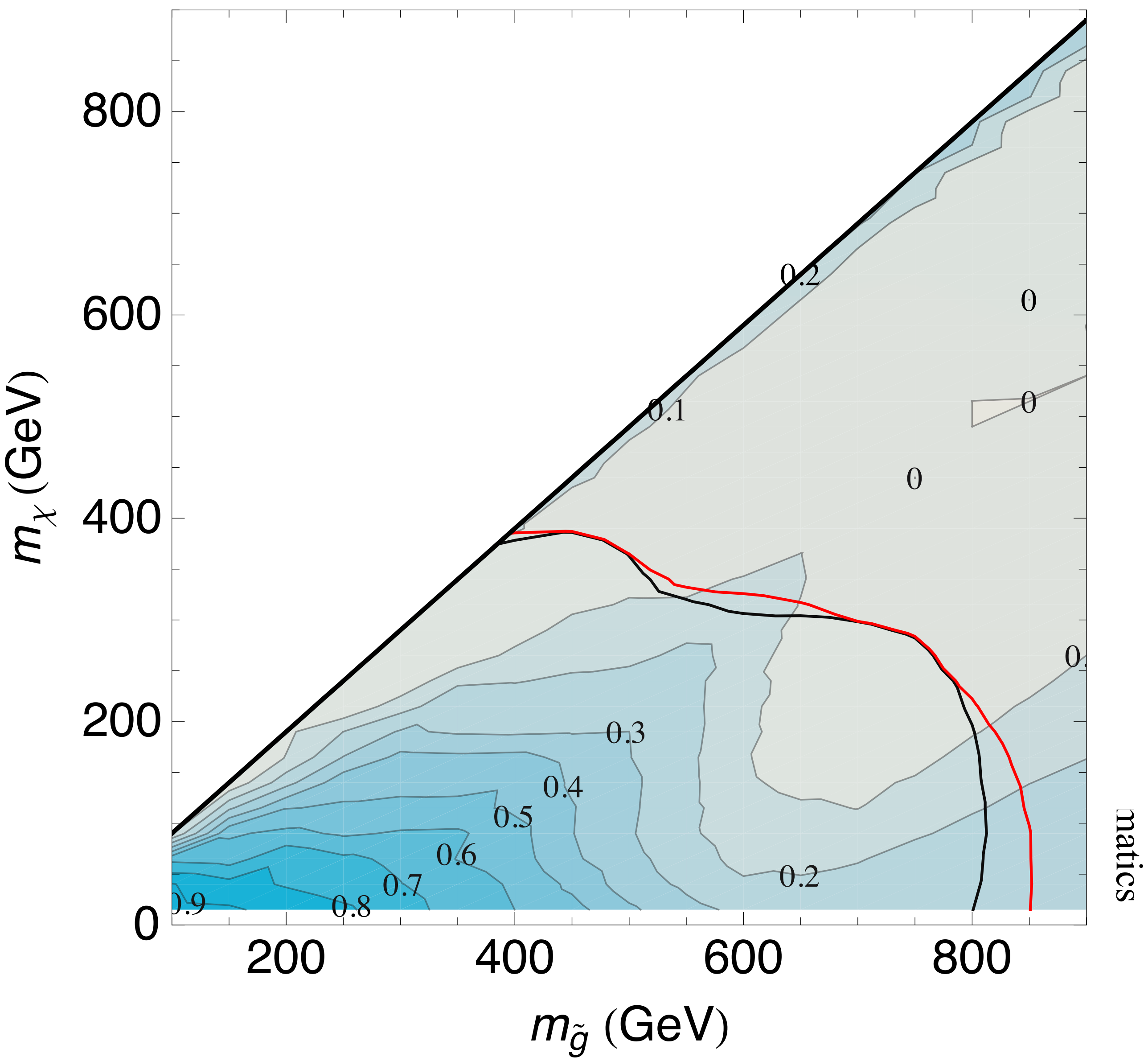
Back Up Slides

Lower Systematics, similar searches

$$\tilde{g} \to q\bar{q}\tilde{\chi}^0$$

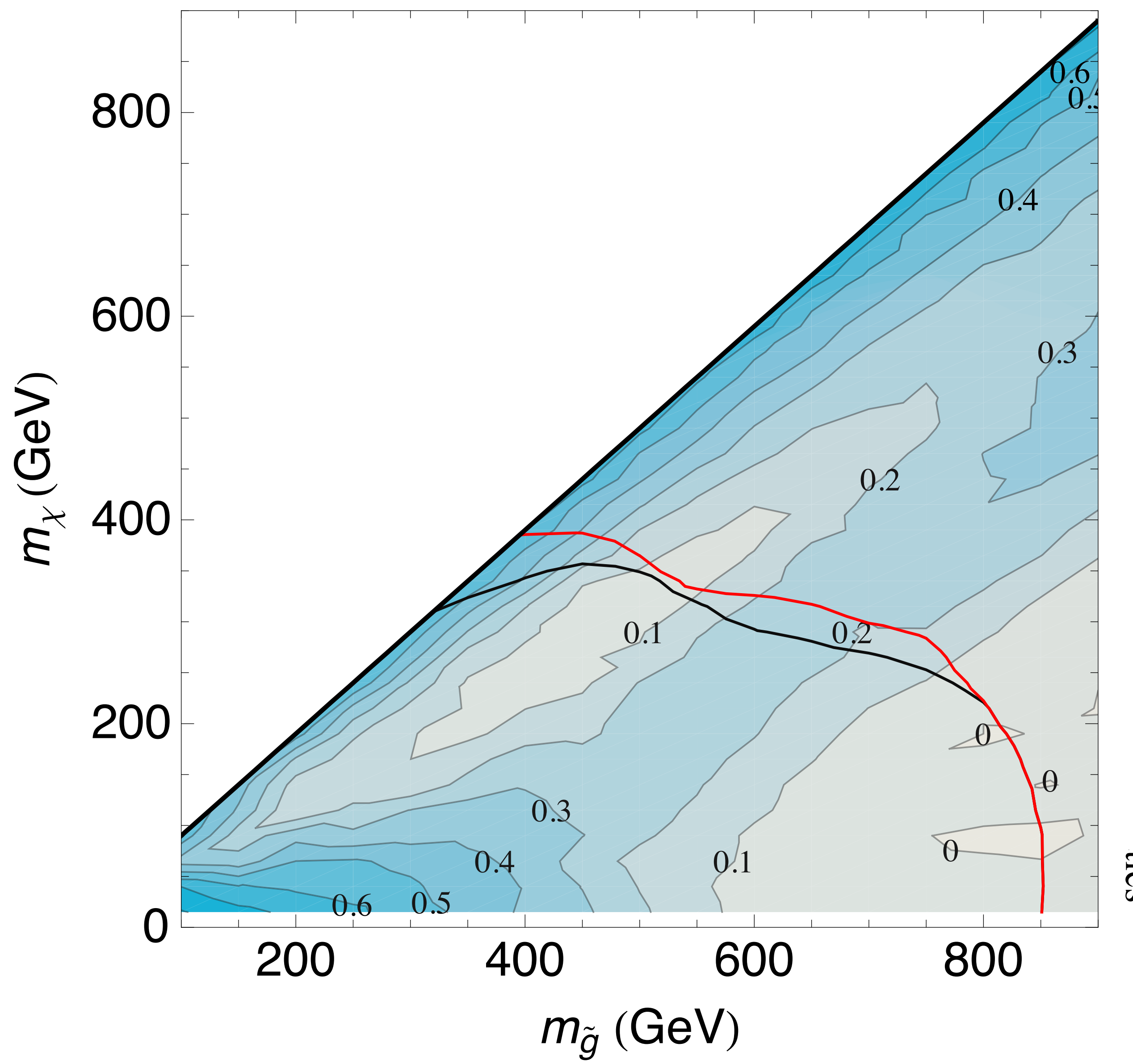
30 % Systematic

$\not{E}_T > 400$ GeV $\quad H_T > 500$ GeV



Low H_T

$\not{E}_T > 300$ GeV $\quad H_T > 900$ GeV



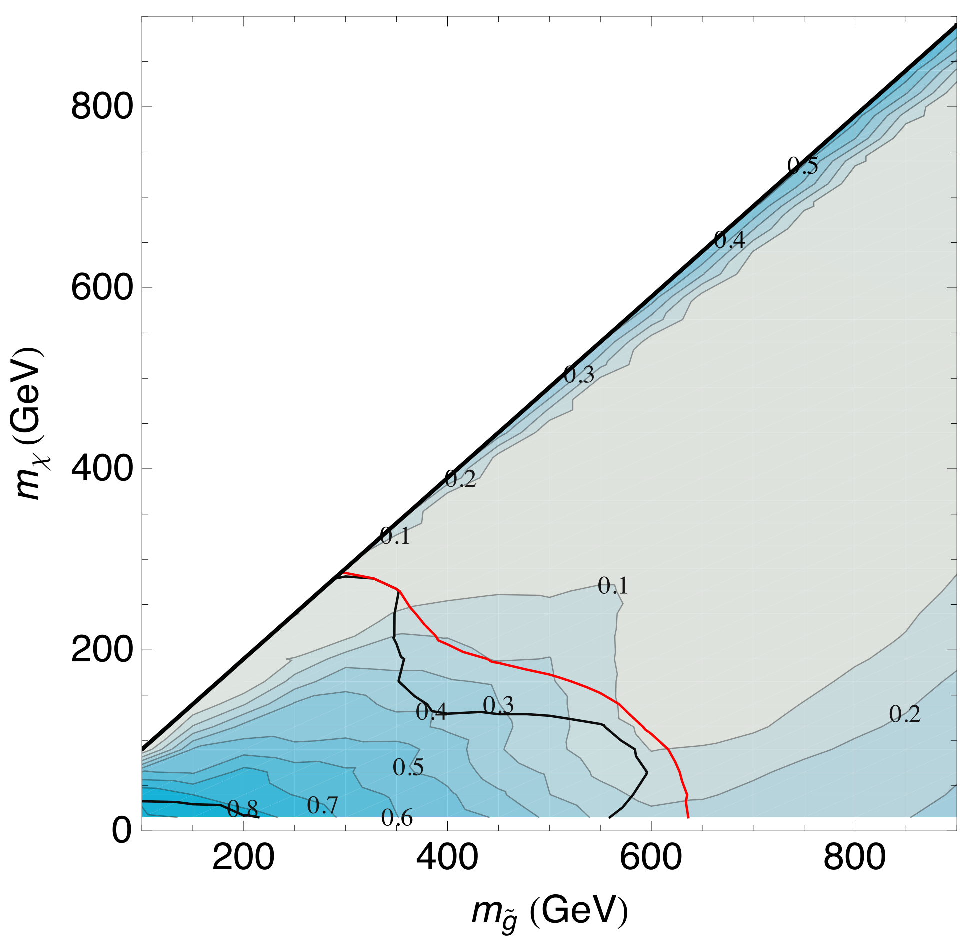
High H_T

Prospects for Discovery

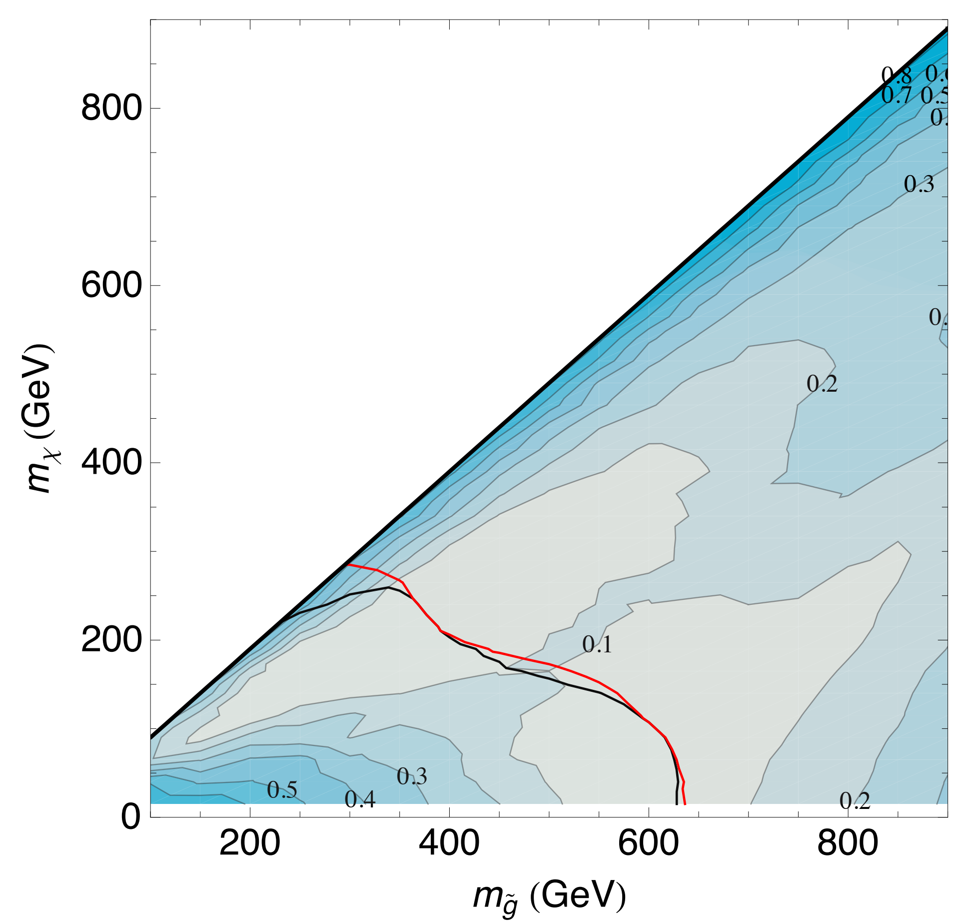
We define a theory discoverable if: $S > 5\sqrt{SL(B)^2 + (\epsilon_{syst} * B)^2}$

$$\tilde{g} \rightarrow q\bar{q}\tilde{\chi}^0$$

$H_T > 400$ GeV $\quad \not{E}_T > 400$ GeV



$H_T > 800$ GeV $\quad \not{E}_T > 300$ GeV

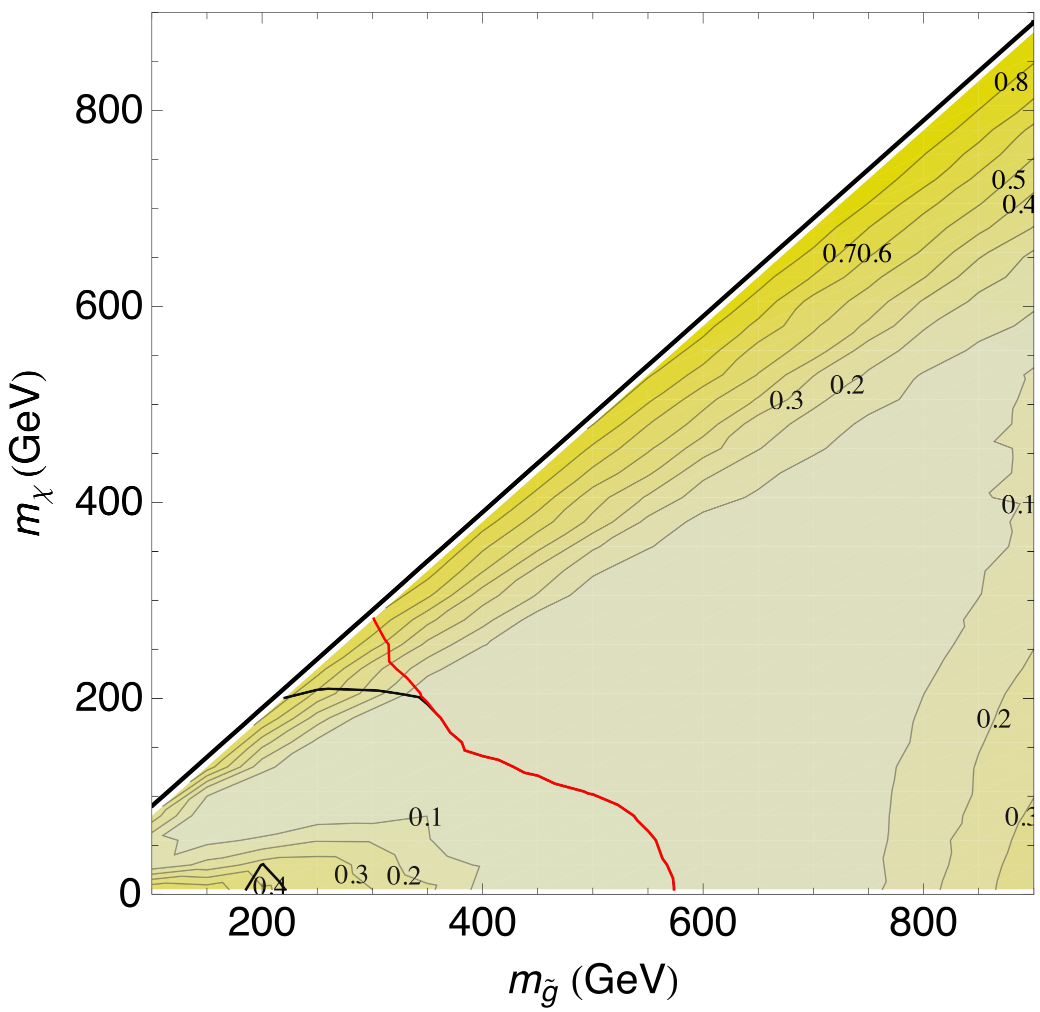


50% Syst

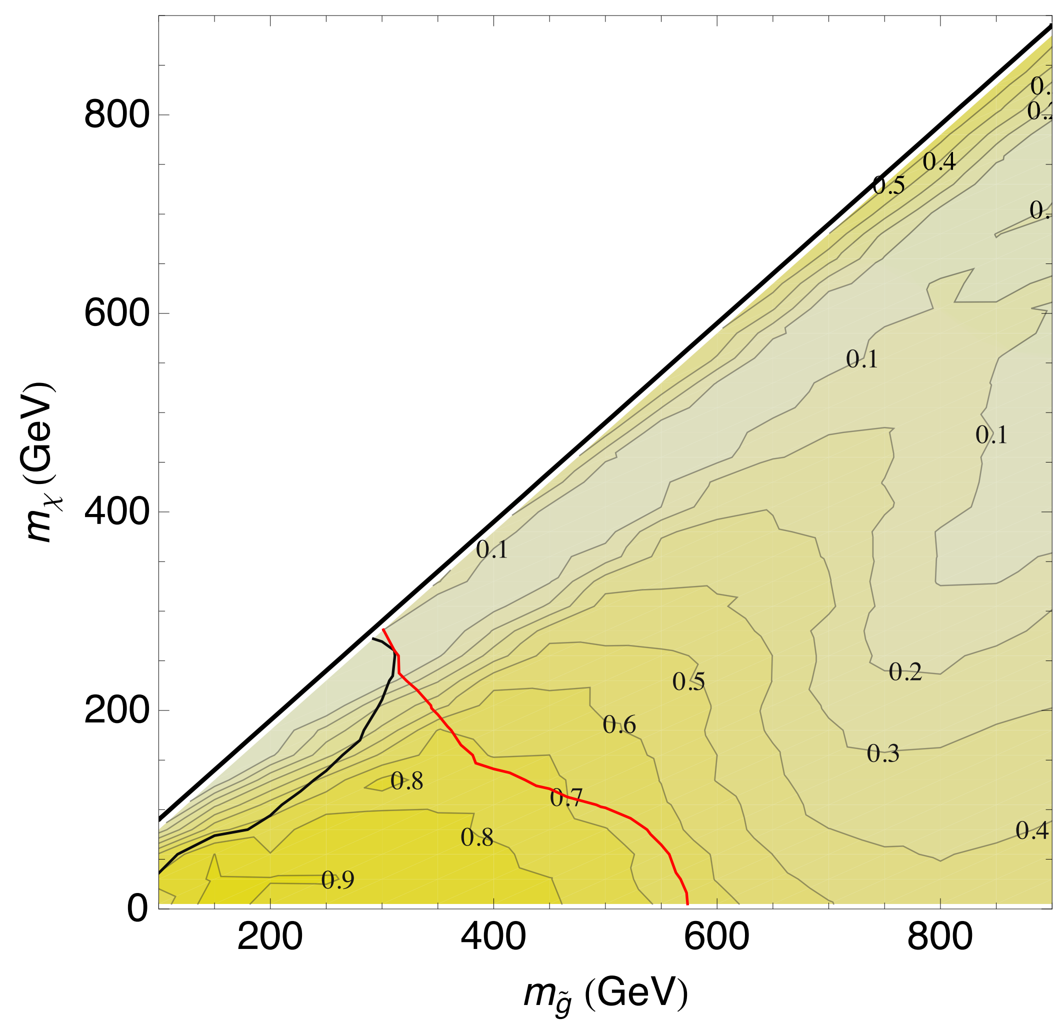
Prospects for Discovery

$$\widetilde{g} \rightarrow qq'\widetilde{\chi}^{\pm} \rightarrow qq'(W^{*}\chi^{0})$$

$H_T > 900$ GeV $\quad \not{E}_T > 225$ GeV



$H_T > 700$ GeV $\quad \not{E}_T > 400$ GeV



$$50\% \text{ Syst}$$

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How we used this result

$$N_s = \mathcal{L}\ \sigma(pp \to \tilde{g}\tilde{g}X)\ \epsilon(m_{\tilde{g}}, m_\chi)$$

$$P(N_{s+b} \leq N_{\text{obs}}) \geq 5\%$$

$$P(N_{s+b} \leq N_{\text{obs}}) = \sum_{n}^{N_{\text{obs}}} \text{Poisson}(n;\ N_{s+b})$$

$$\text{Poisson}(n;\ \lambda) = \frac{\lambda^n}{n!} e^{-\lambda}$$

How we used this result

$$N_s = \mathcal{L}\ \sigma(pp \to \tilde{g}\tilde{g}X)\ \epsilon(m_{\tilde{g}}, m_\chi)$$

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$$P(N_{s+b} \leq N_{\text{obs}}) = \sum_{n}^{N_{\text{obs}}} \text{Poisson}(n;\ N_{s+b})$$

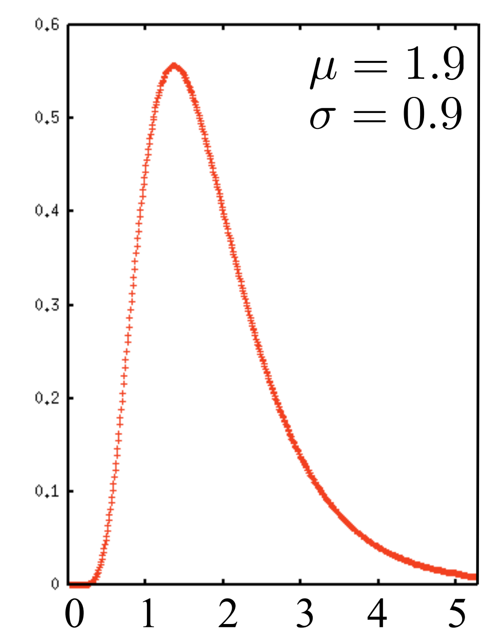
$$\text{Poisson}(n;\ \lambda) = \frac{\lambda^n}{n!} e^{-\lambda}$$

Fold in uncertainties:

$$\int d\mathcal{L}\ f'(\mathcal{L}; \mu_{\mathcal{L}}, \sigma_{\mathcal{L}}) \cdot \qquad \mathcal{L} = 70 \pm 8\ \text{nb}^{-1}$$

Normal distribution

$$\int dN_B\ f(N_b; \mu_b, \sigma_b) \cdot \qquad N_{b\ 3+j} = 1.9 \pm 0.9$$



Log Normal distribution (keeps background positive)

3 jet channel most important

Best limit on cross section

$\sigma_{3+j}\ \epsilon \leq 20\ \text{pb}$ vs $\sigma_{4+j}\ \epsilon \leq 57\ \text{pb}$

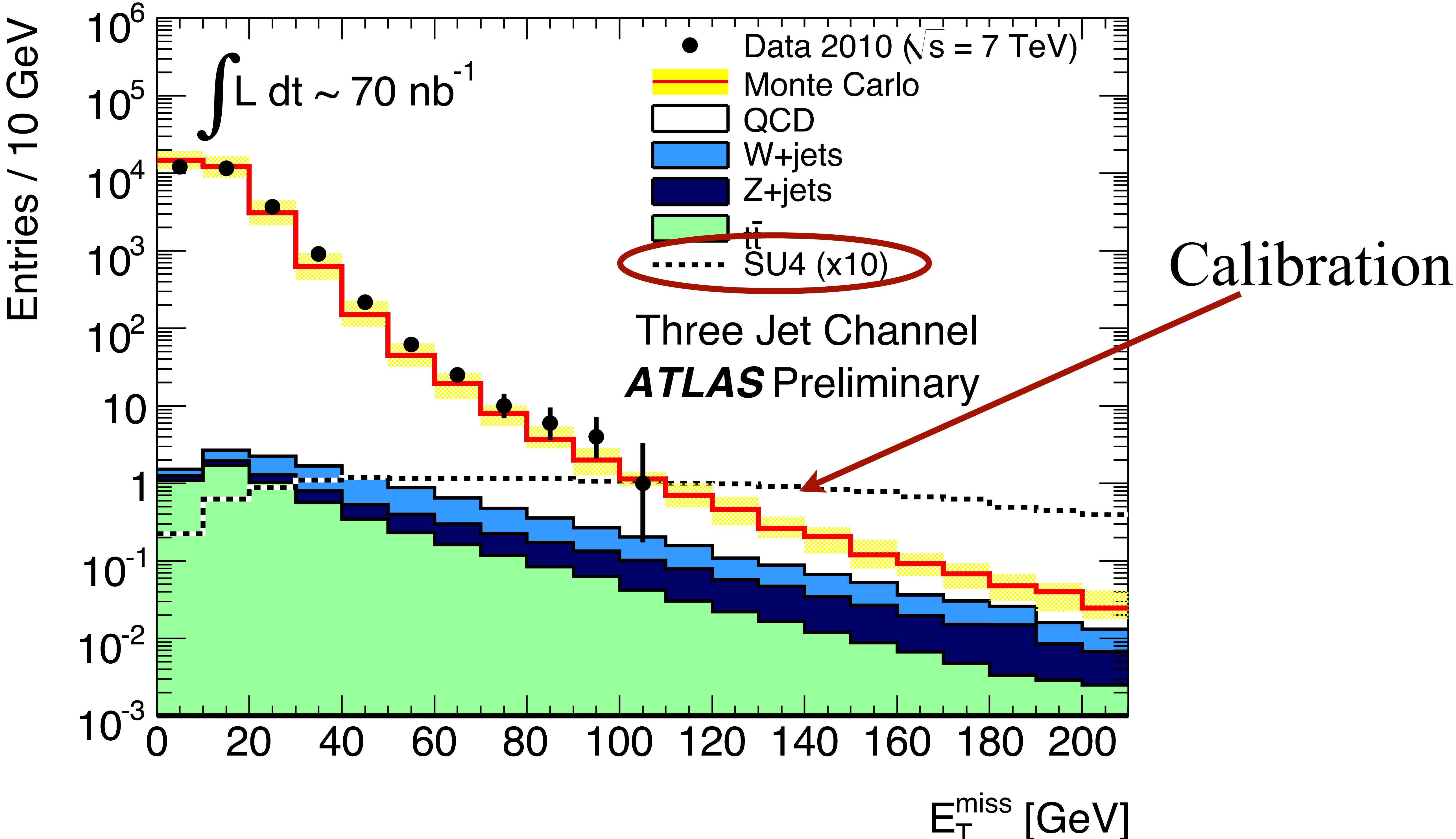
Efficiency lower to get 4 jets with $p_T > 30\ \text{GeV}$

for $(m_{\tilde{g}}, m_{\chi}) \simeq (300, 0)\ \text{GeV}$

leads to jet with energies of $E_j \sim 100\ \text{GeV}$

only 50% of the events that pass $p_{T\,j3} > 30$ GeV,
pass $p_{T\,j4} > 30$ GeV

Our validation procedure



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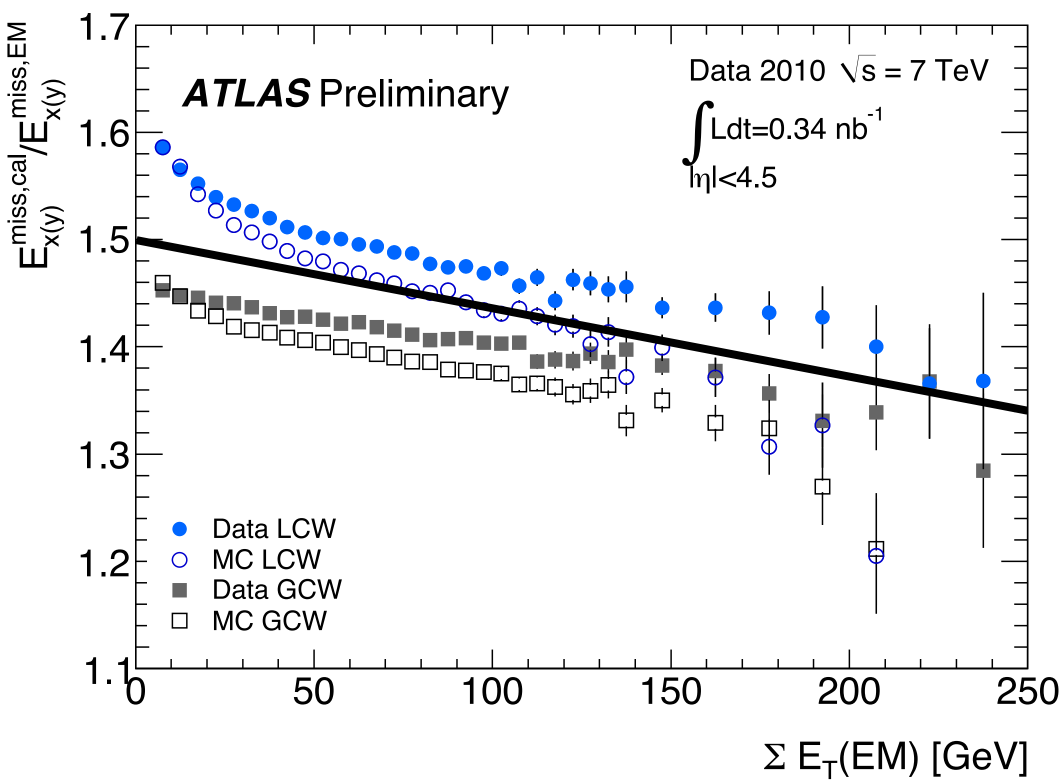
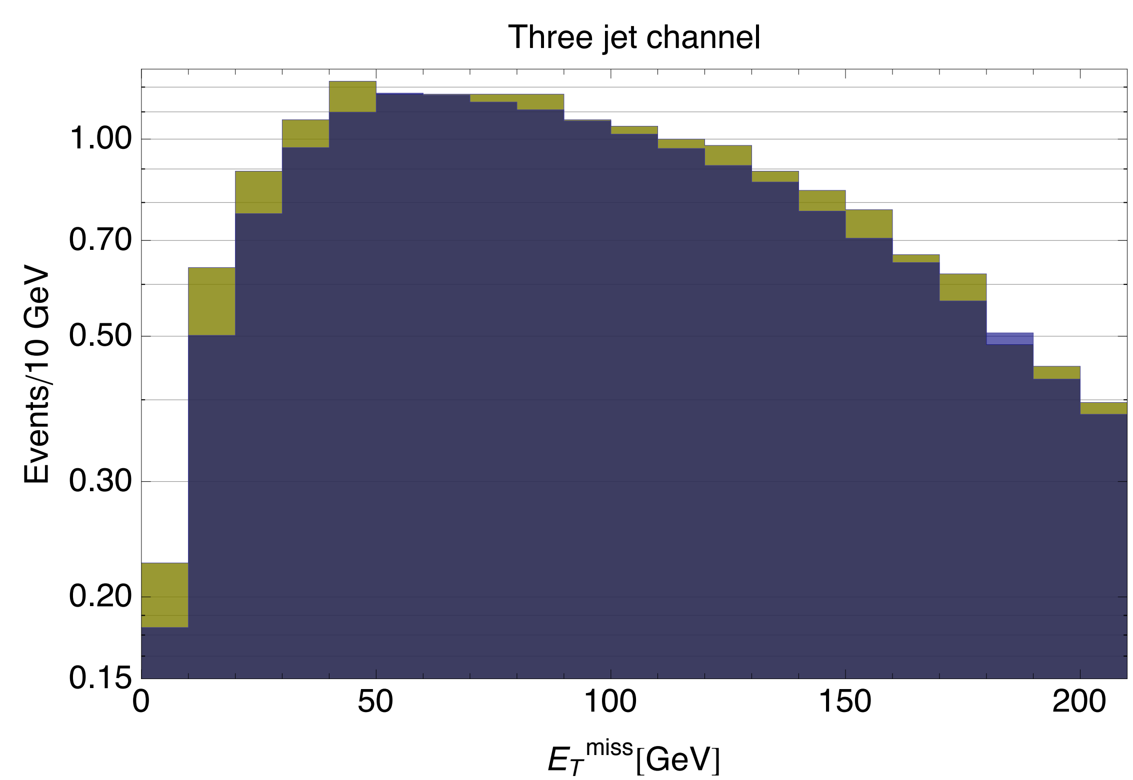
PGS MET mock up

Missing transverse momentum is computed from calorimeter cells belonging to topological clusters at the electromagnetic scale [30]. No corrections for the different calorimeter response of hadrons and electrons/photons or for dead material losses are applied. The transverse missing momentum

“true” MET/“EM” MET

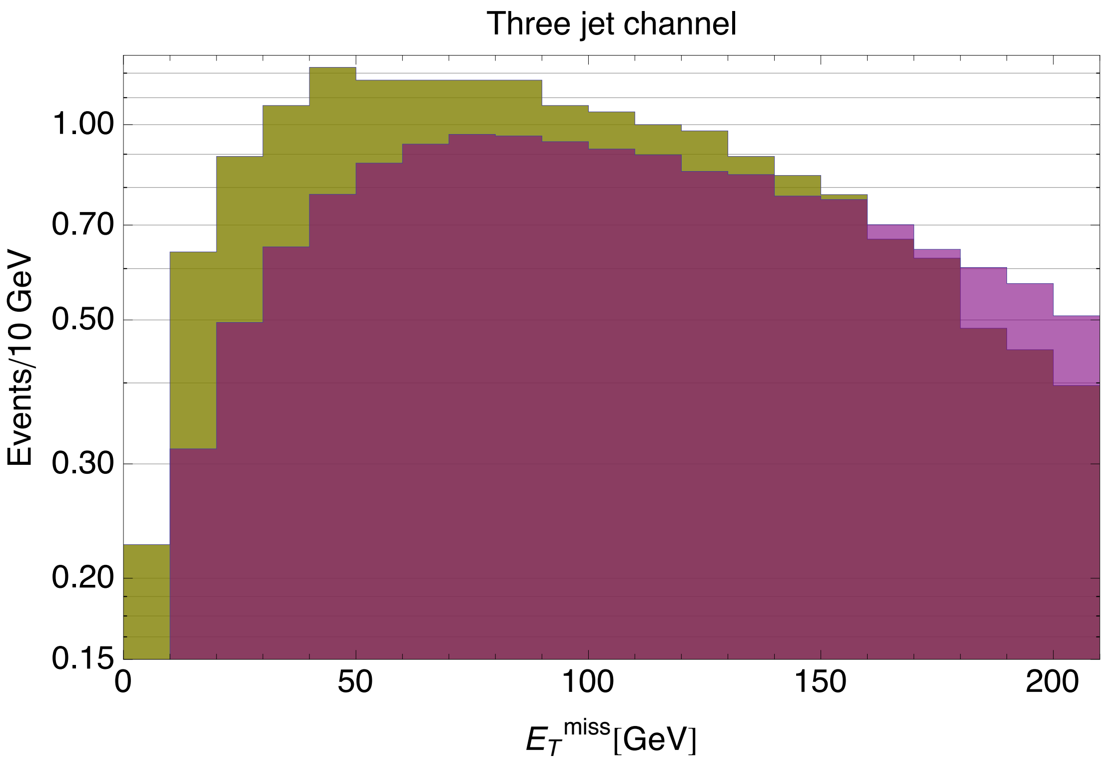


PGS MET with linear fit to Sum ET

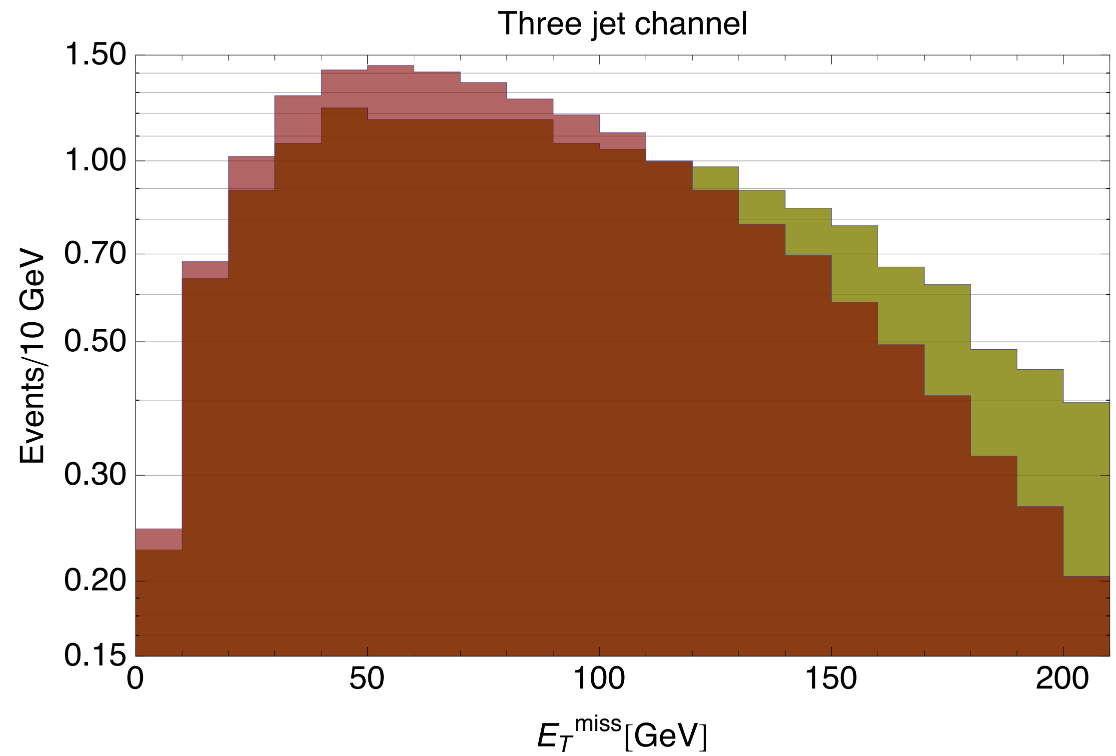


Effectively raises MET cut by 35% to 50%

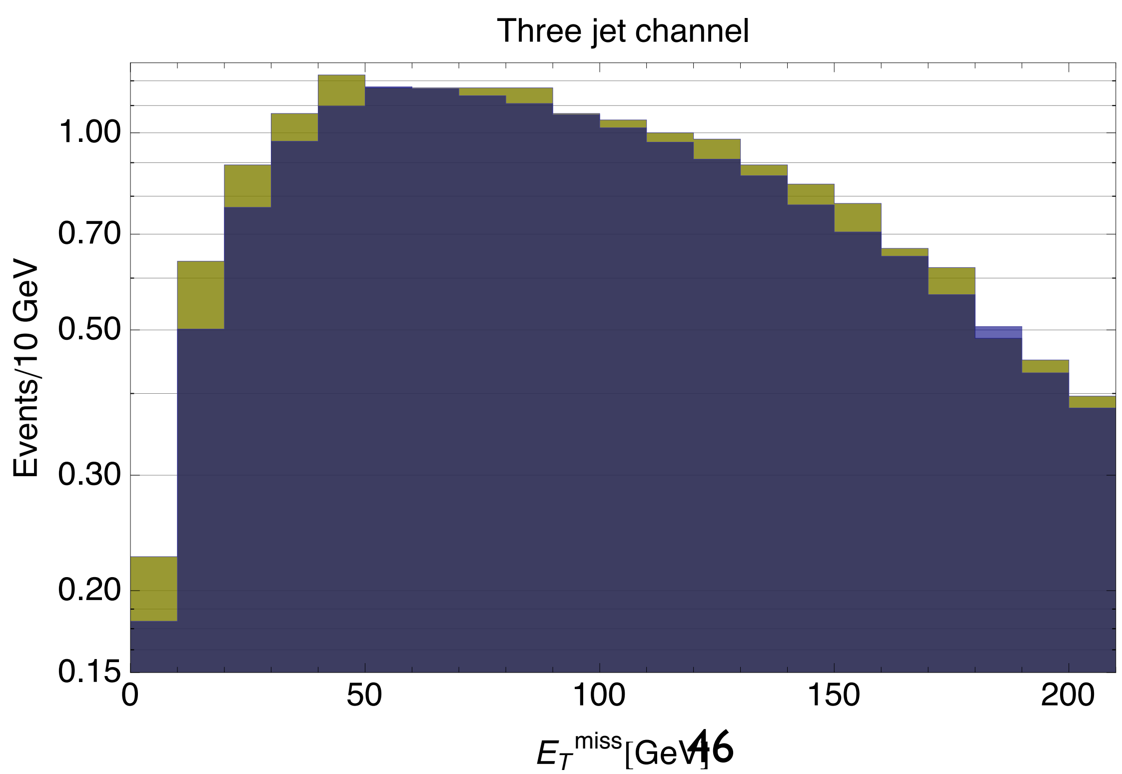
Straight PGS MET



PGS/1.5



PGS MET with linear fit to Sum ET



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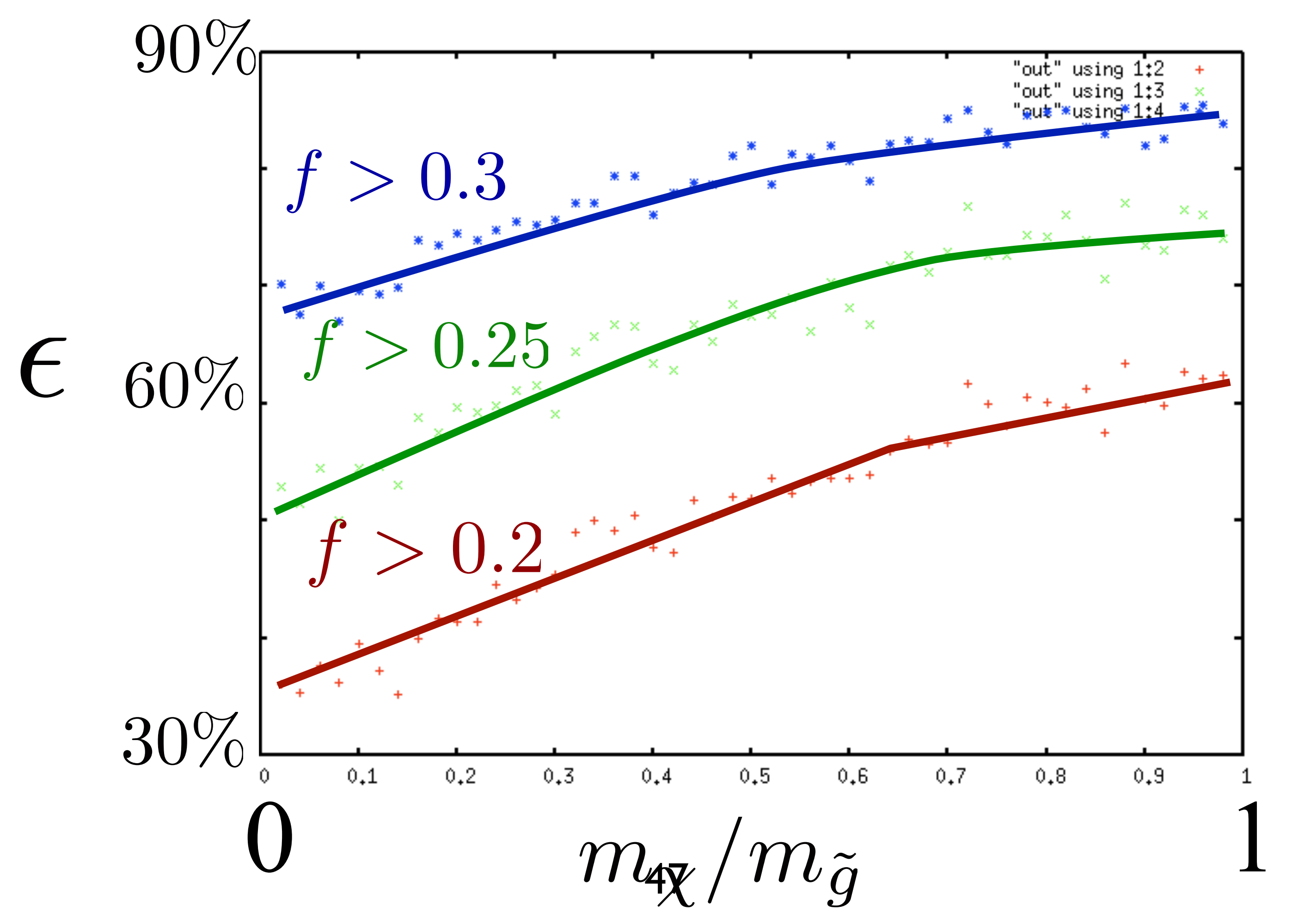
rel. norm. = 94%
cut ε_{ATLAS} = 84%
cut ε_{model} = 86%

The slight loss of sensitivity at lower LSP mass from fractional MET cut

$$f = \frac{\not{E}_T}{H_T + \not{E}_T}$$

In limit $m_\chi \longrightarrow m_{\tilde{g}}$, $p_\chi = E_j$

maximizes *f*, and drops for lighter LSP



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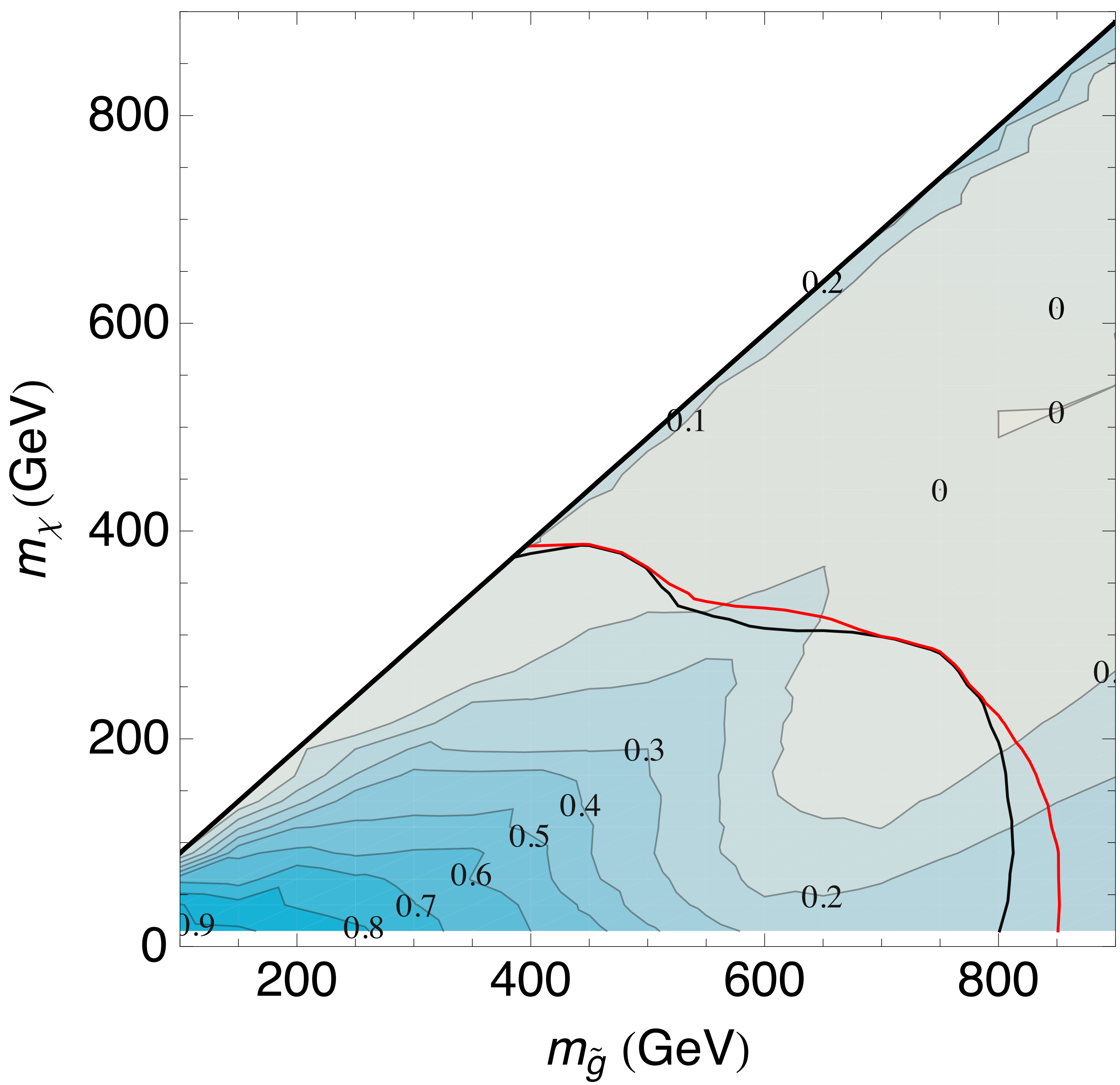
Best searches, 4^{+}Jets, Large MET

$\not\!\!E_T > 400$ GeV



$\tilde{g} \rightarrow q\bar{q}\tilde{\chi}^0$

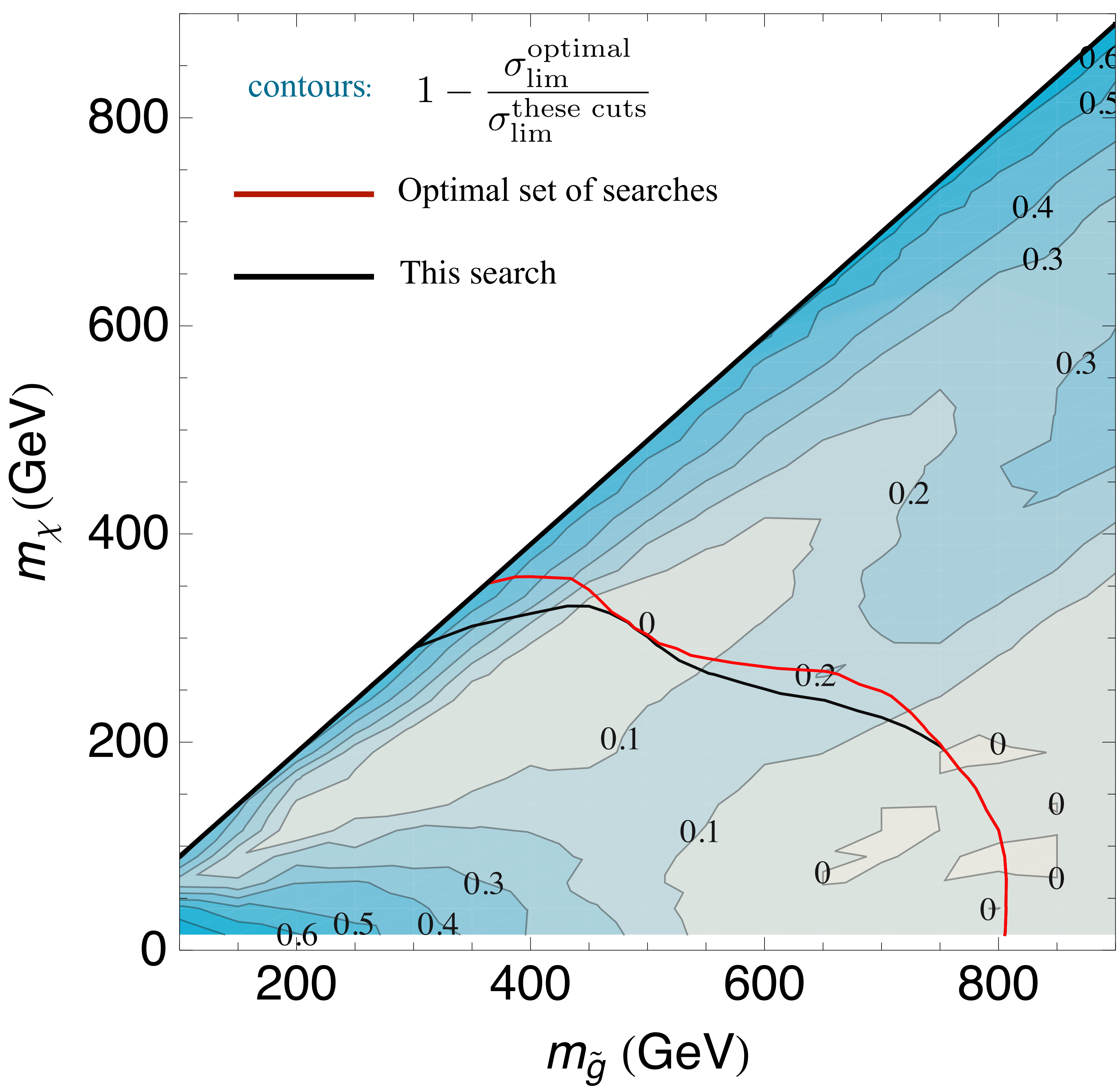
50% Syst

contours: $1 - \frac{\sigma_{\rm lim}^{\rm optimal}}{\sigma_{\rm lim}^{\rm these\ cuts}}$

Optimal set of searches

This search

Additional reach from lower MET search



$$H_T > 900 \text{ GeV}$$

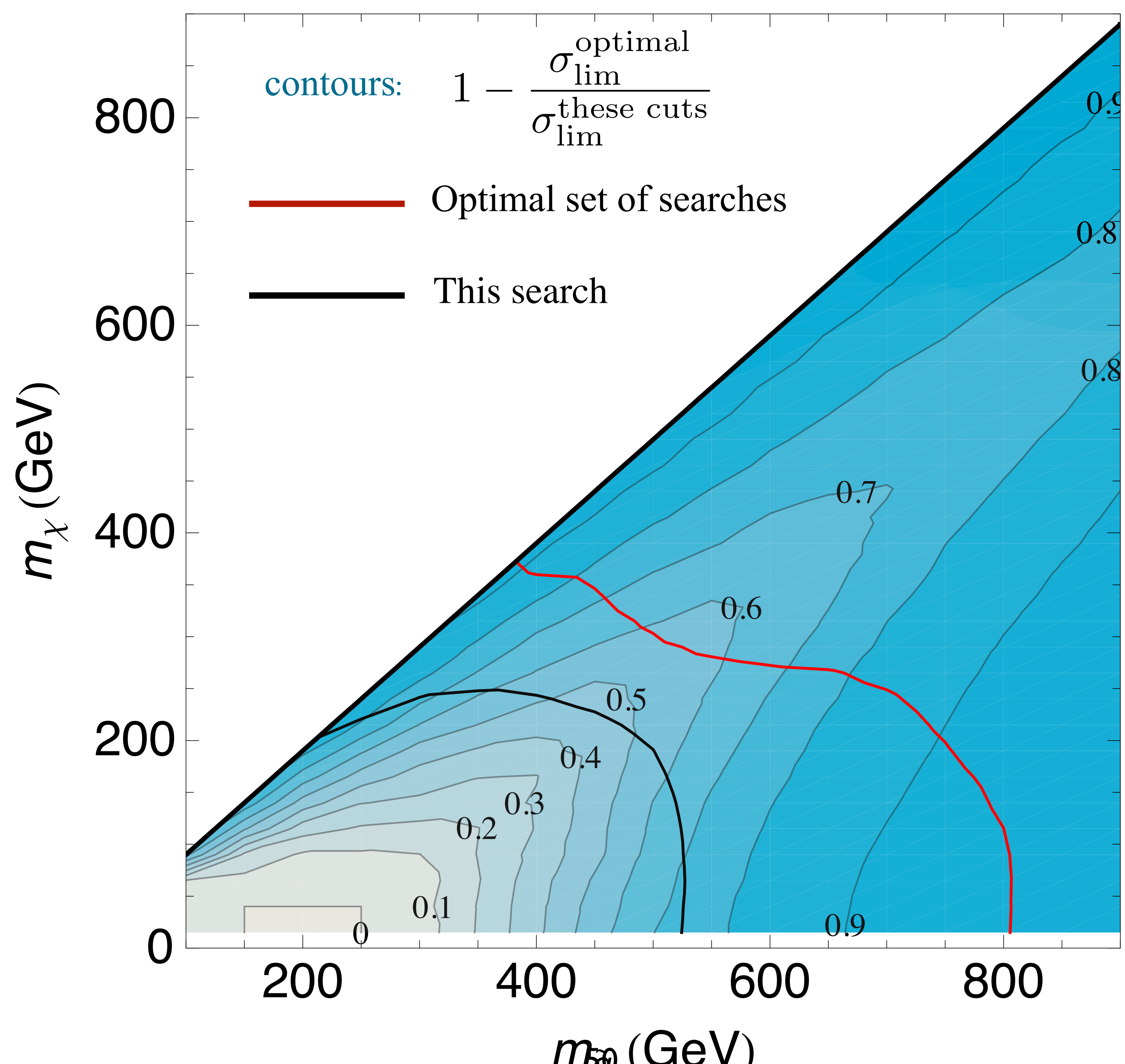
$$\not{E}_T > 300 \text{ GeV}$$

50% Syst

Best sensitivity for lower masses

(close to nominal ATLAS SUSY search)

$H_T > 500$ GeV $\quad\quad \not{E}_T > 100$ GeV



$\tilde{g} \to q\bar{q}\tilde{\chi}^0$

50% Syst