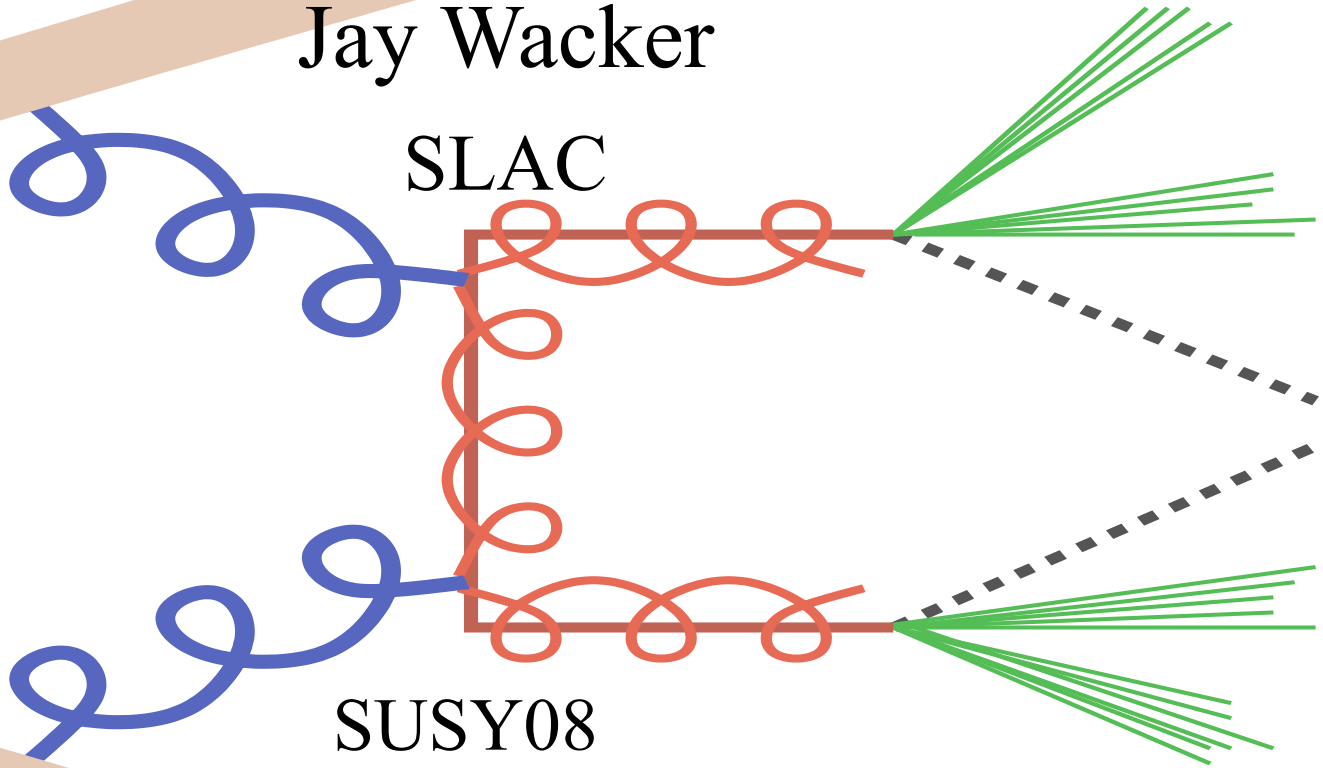
Discovering Gluinos Away From mSugra

Jay Wacker

SLAC



SUSY08

June 17, 2008

0803.0019 & work in progress
with J. Alwall, M-P. Le, M. Lisanti

Where are the gluinos?

Current Limits are > 320 GeV

Color Octet, EW Singlet

R-parity conserving

Lightest colored particle

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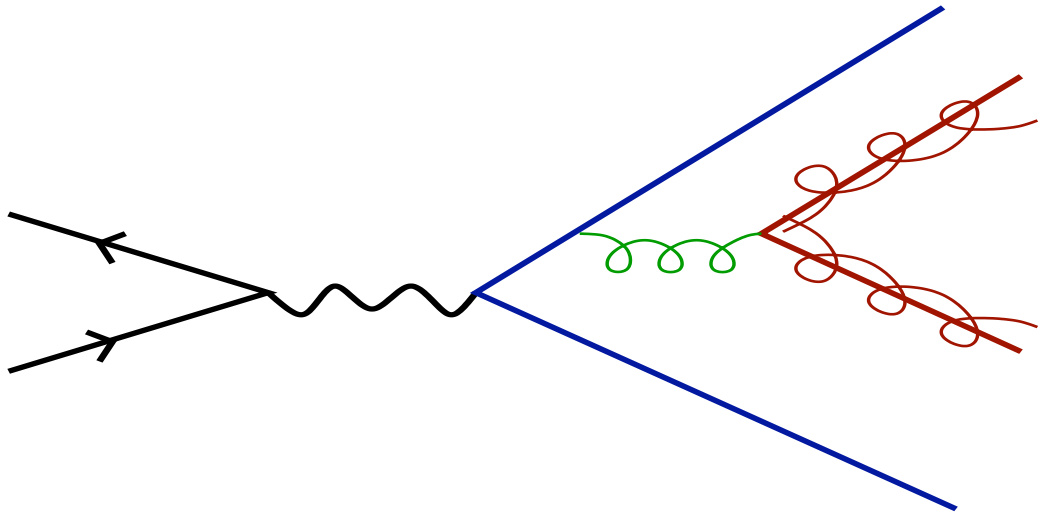
Can gluinos be 50 GeV?

Clean limit where signal is only jets and MET

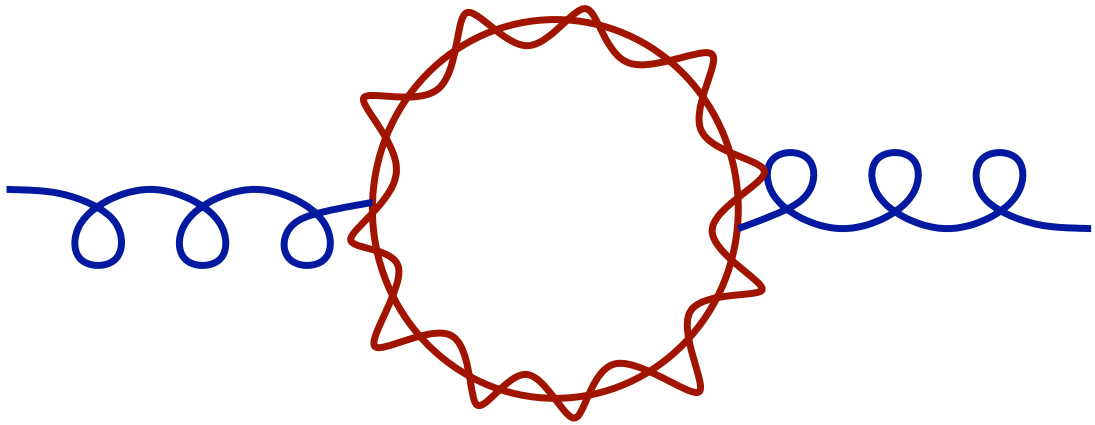
No LEP limits

LEP Doesn't Produce Gluinos



$m_{\tilde{g}} \gtrsim 30$ GeV

Best limits come from Thrust



$m_{\tilde{g}} \gtrsim 50$ GeV

Hadron Machines only way to discovering

Jets + Missing Energy Searches at D0

85pb^{-1} + 2fb^{-1} analyses

	Gg	$\tilde{q}\tilde{q}$	$\tilde{q}\tilde{g}$	$\tilde{g}\tilde{g}$
	$1j + \not{E}_T$	$2j + \not{E}_T$	$3j + \not{E}_T$	$4j + \not{E}_T$
$E_{T\,j_1}$	≥ 150	≥ 35	≥ 35	≥ 35
$E_{T\,j_2}$	< 35	≥ 35	≥ 35	≥ 35
$E_{T\,j_3}$			≥ 35	≥ 35
$E_{T\,j_4}$				≥ 20

(Not exclusive searches)

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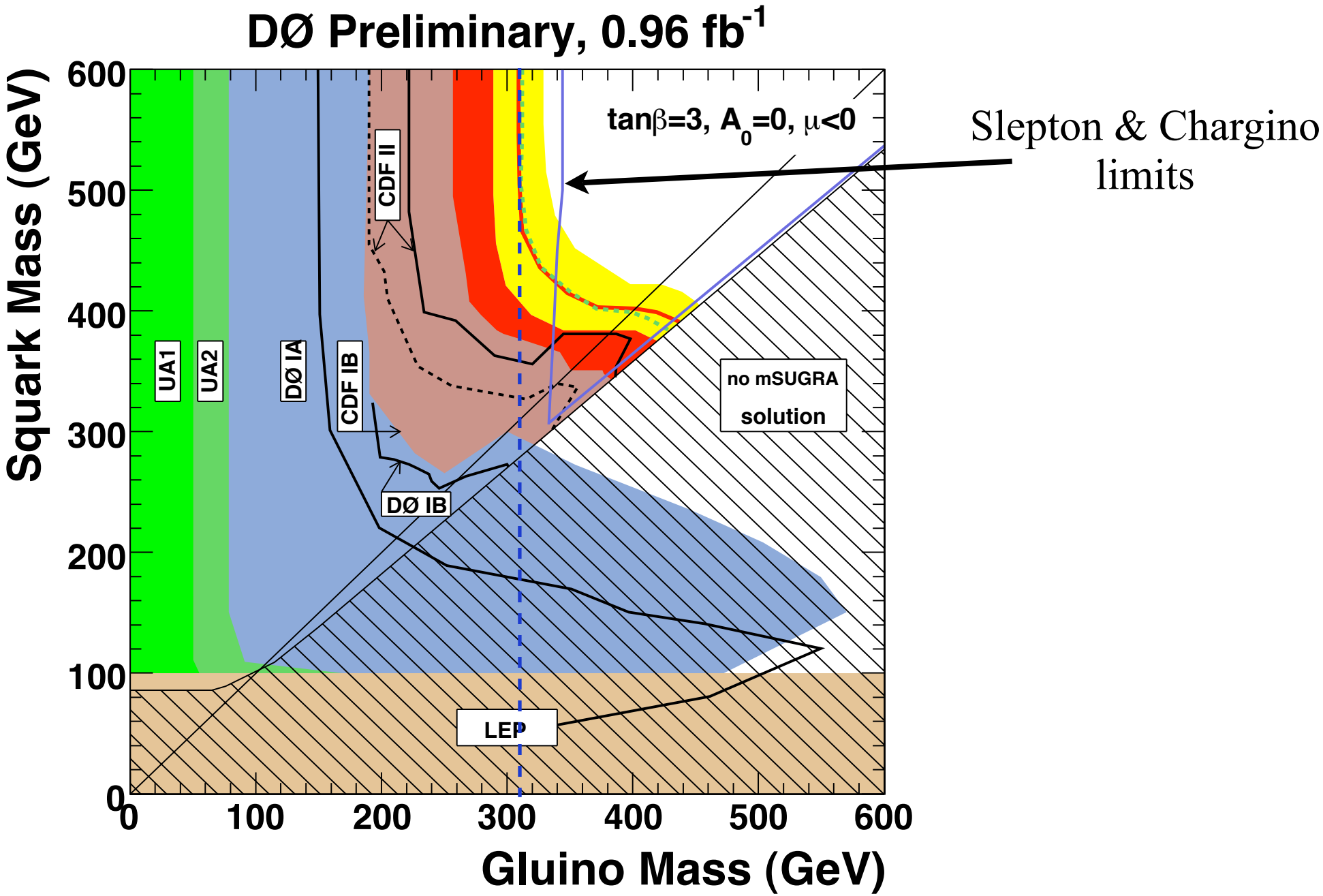
$\not{E}_T$	≥ 150	≥ 225	≥ 150	≥ 100
H_T	≥ 150	≥ 300	≥ 400	≥ 300

$$H_T = \sum E_{T\,j}$$

(Not exclusive searches)

Will these discover anything visible in these channels?

What we know about gluino limits



mSugra is not representative of the MSSM

$$m_{\tilde{g}} : m_{\tilde{B}} = 6 : 1$$

Anomaly Mediation

Mirage Mediation

non-Minimal Gauge Mediation

(never mind: UED, RS/LH with T-parity)

Never varies decay kinematics

Are there visible signals that could be missed?

Backgrounds are challenging

Examining $\tilde{g}\tilde{g}$ more carefully

The "gluino" module

Turn on one decay mode $\tilde{g} \longrightarrow q\bar{q}\tilde{\chi}^0$

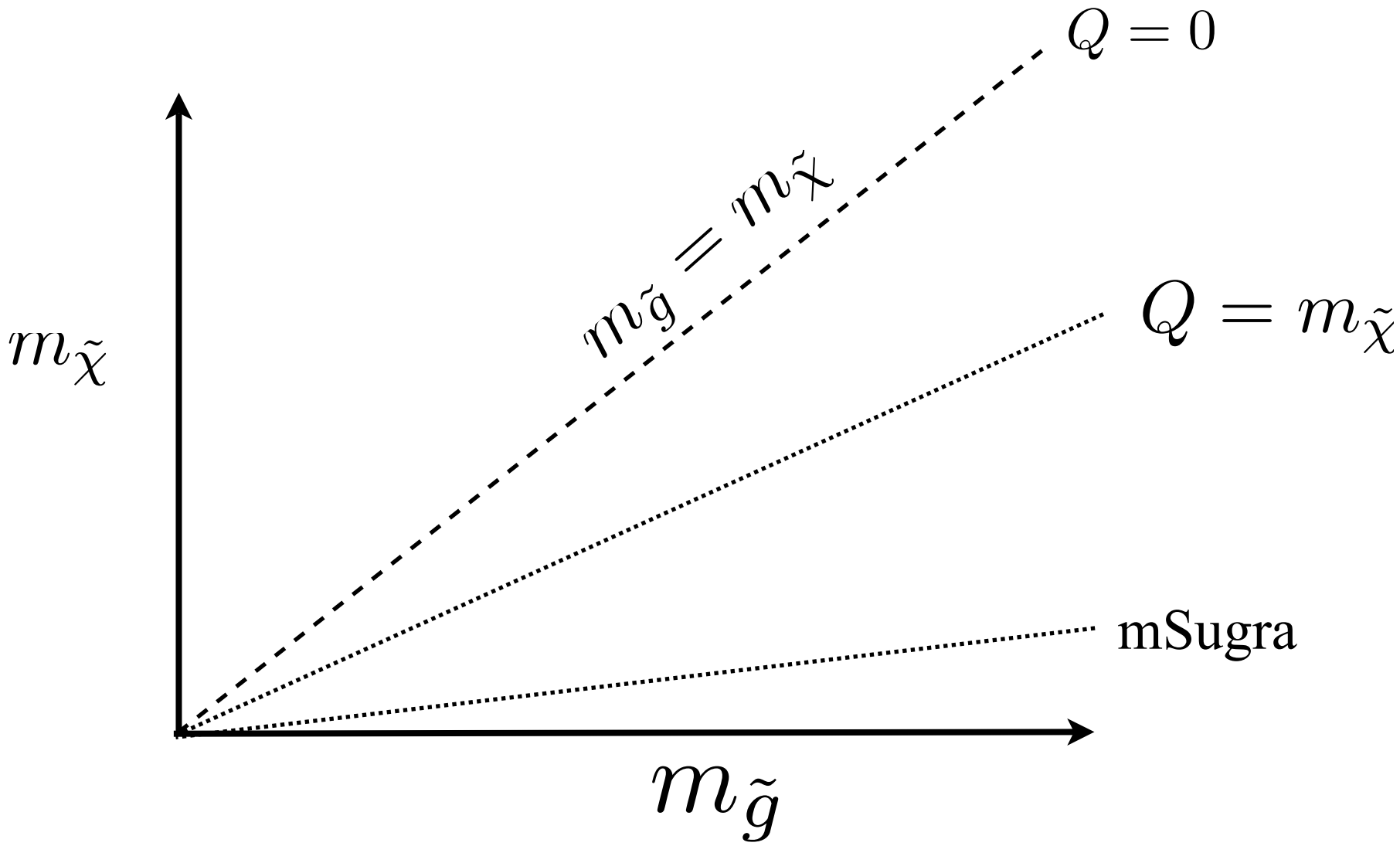
Keep masses and total cross section free

$m_{\tilde{g}}$ $m_{\tilde{\chi}}$ $\sigma(p\bar{p} \longrightarrow \tilde{g}\tilde{g}X)$

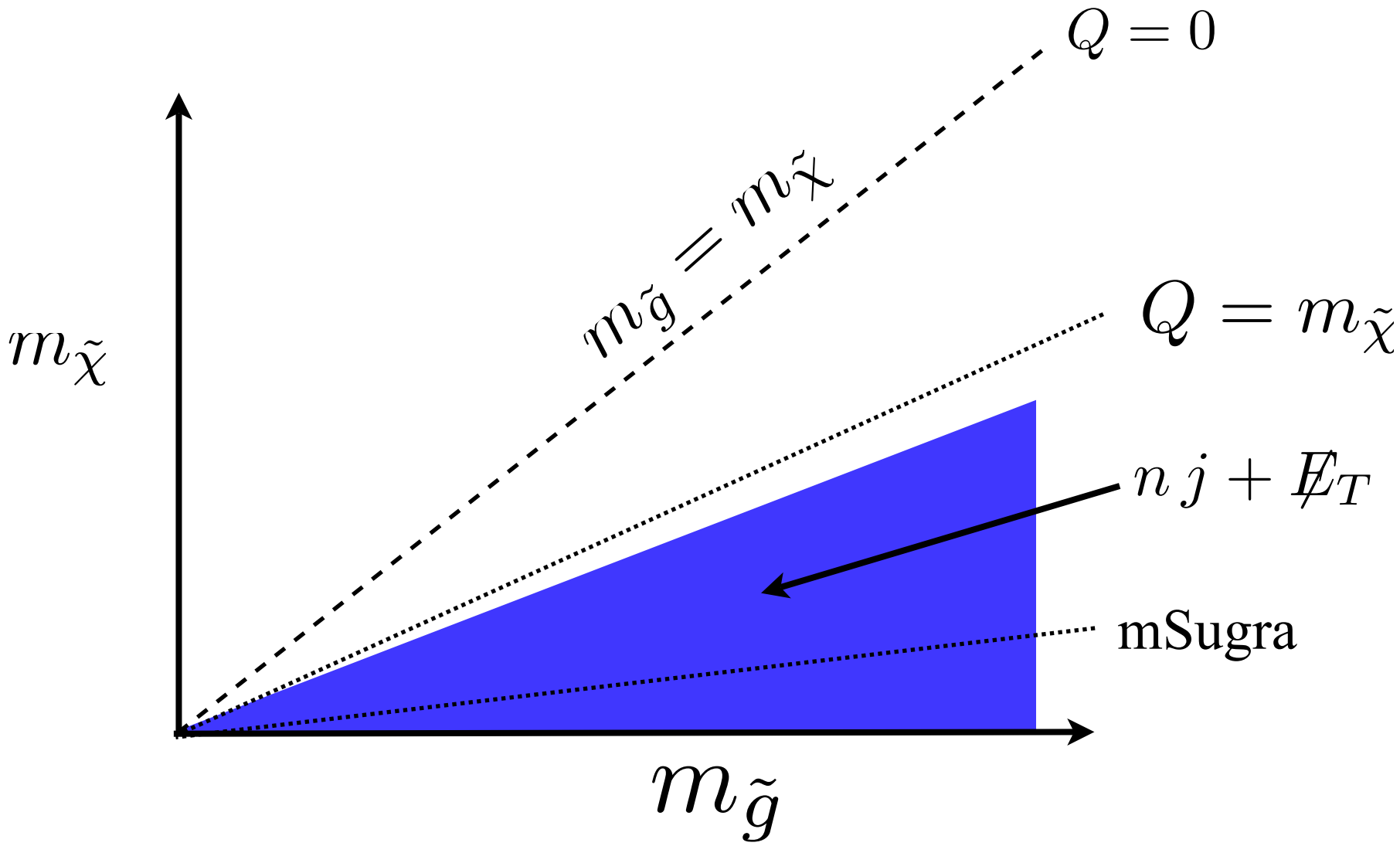
Captures many models (MSSM, UED, etc)

Misses heavy flavor and cascades

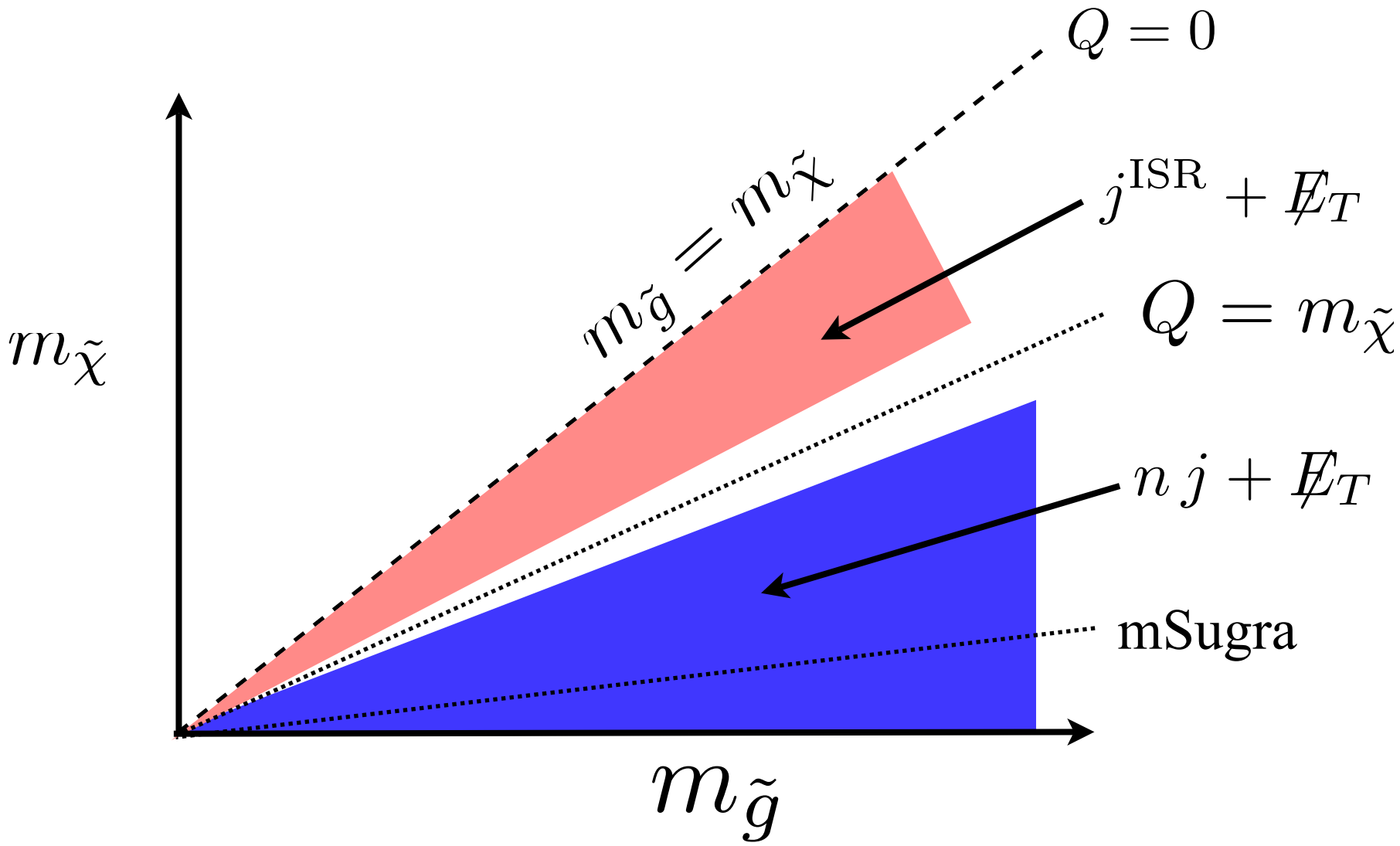
Searches useful in gluino searches



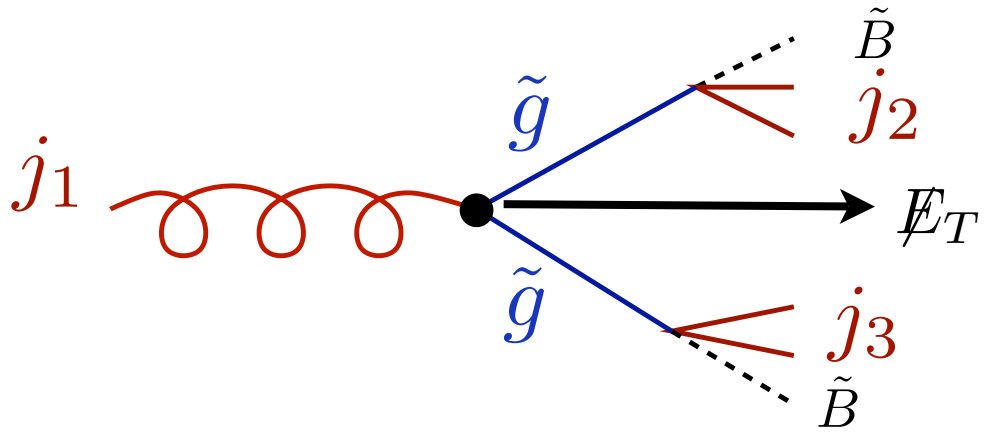
Searches useful in gluino searches



Searches useful in gluino searches



Producing Degenerate Gluinos



Need additional hard jets

Want the spectrum as well

D0

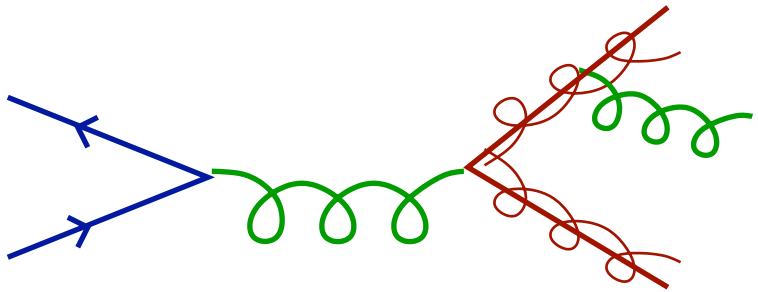
$P_T^{j1} > 150$ GeV
$P_T^{j2} < 50$ GeV
$\not{E}_T > 150$ GeV
$\Delta\Phi^{j\not{E}_T} > 30°$

CDF

$P_T^{j1} > 150$ GeV
$P_T^{j2} < 60$ GeV
$P_T^{j3} < 20$ GeV
$\not{E}_T > 120$ GeV
$\Delta\Phi^{j2\not{E}_T} > 0.3$

Calculating Additional Jets

See. J. Alwall's Presentation



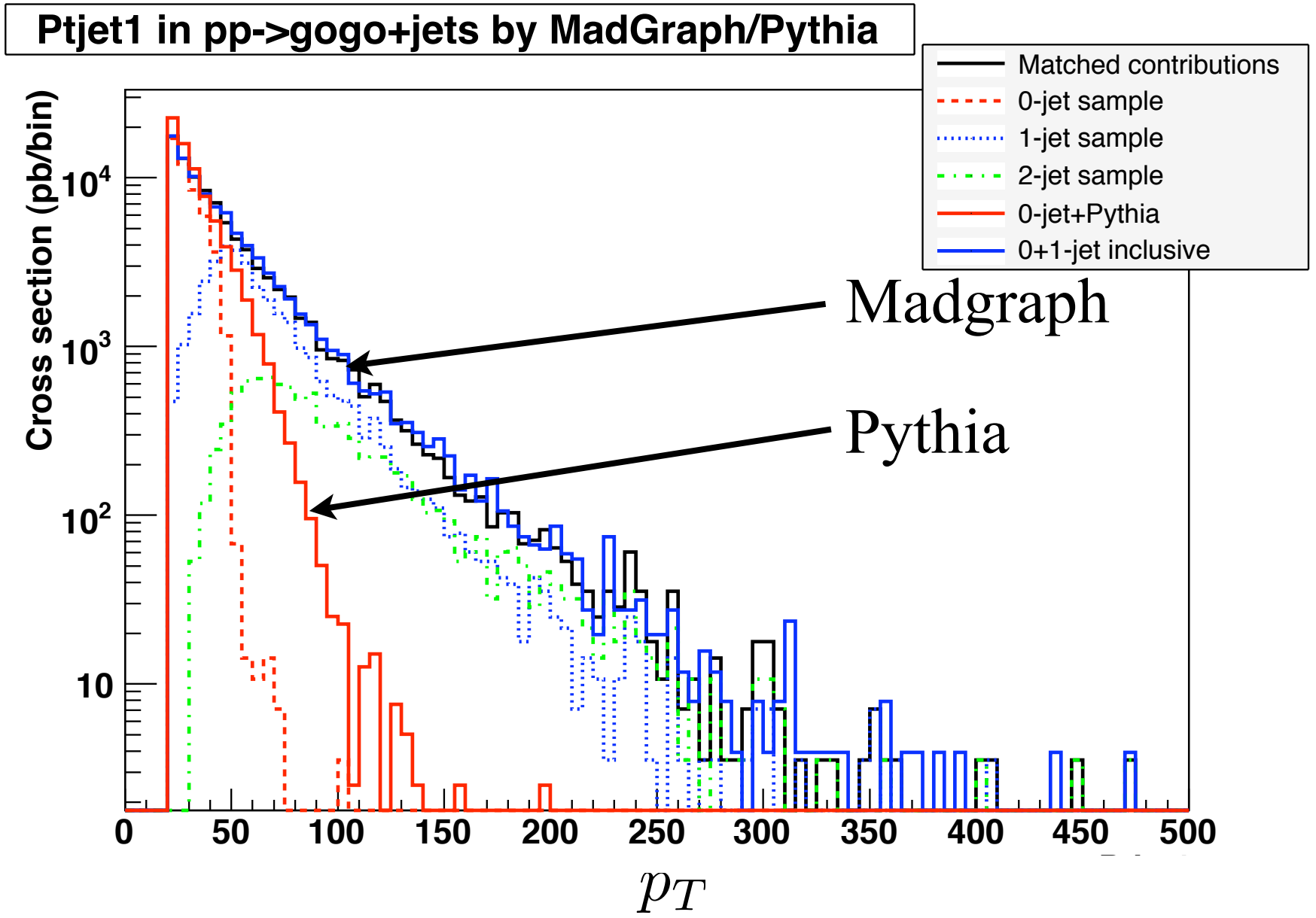
Parton Showering	Matrix Elements
QCD Bremstrahlung	Necessary for well-separated jets
Soft/Collinear Approximation	Includes quantum interference
Resums large logs	Fixed order calculation
Computationally Cheap	Computationally expensive
Unlimited number of partons	Limited number of partons

Matching merges best of both worlds

Necessary to avoid double counting

Need it for the BSM Signal!

Comparison between Matching and Showering



Exclusive Jets + MET Search

4 Separate Searches, Individually Optimized

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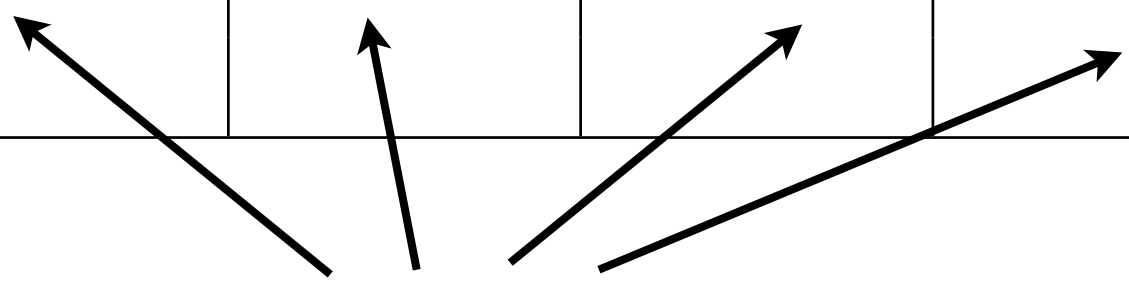
$\not{E}_T$				
H_T				

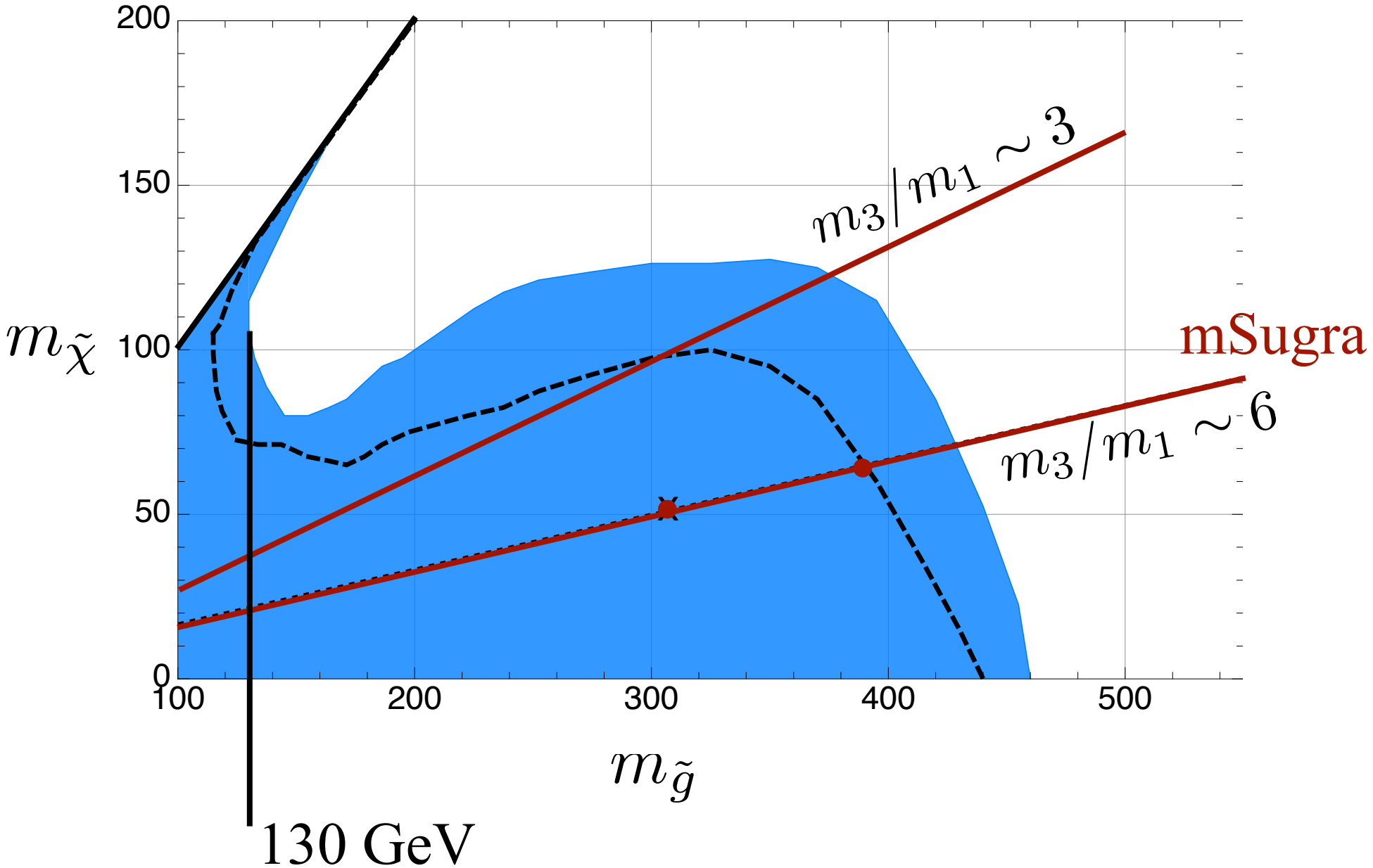


Maximize significance for each $m_{\tilde{g}}, m_{\tilde{\chi}}$

Limit on S/B for exclusion

Sensitivity plot for 2fb^{-1}

S/B>1



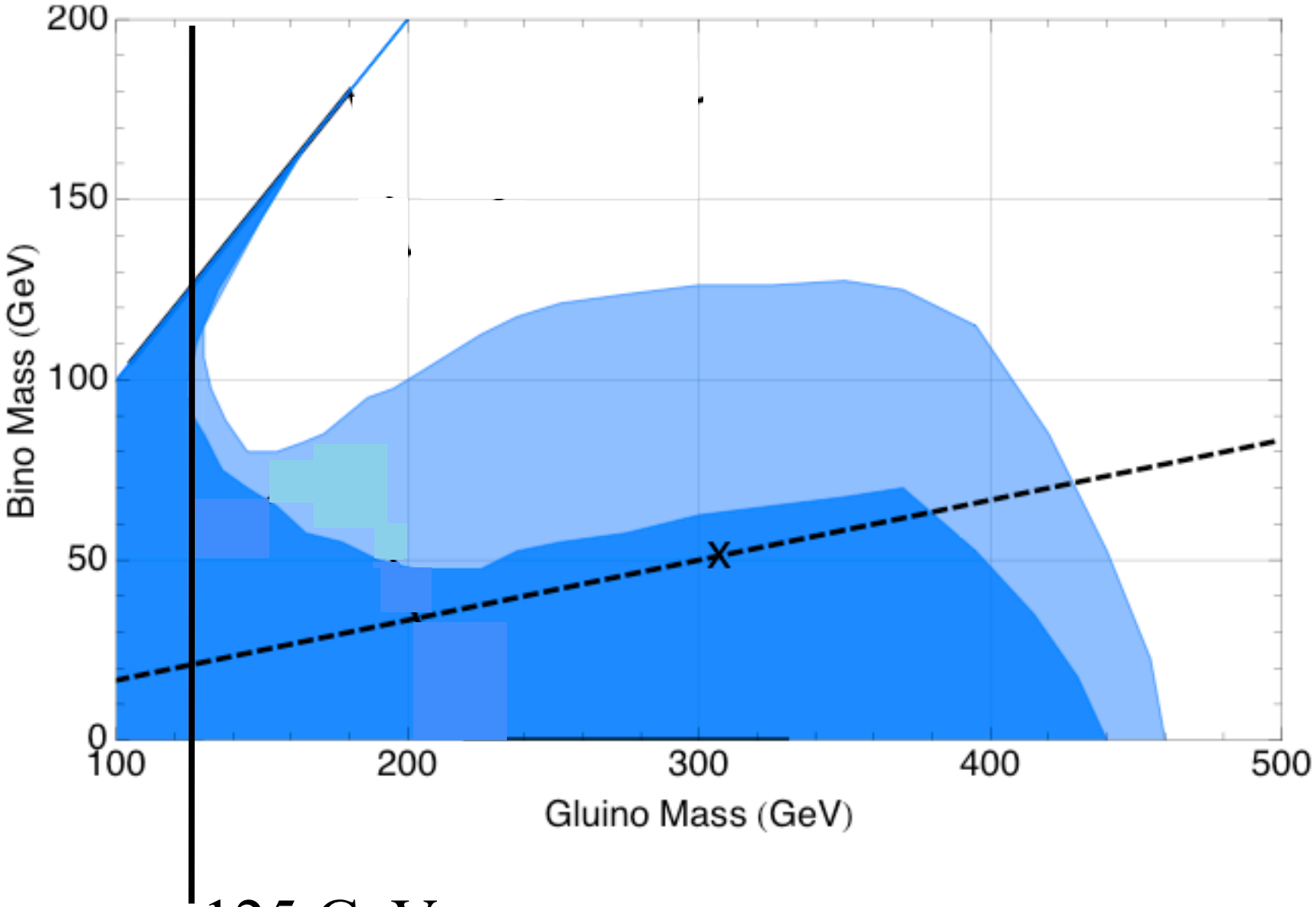
Have only focused on $\tilde{g}$ module

Other modules

$\tilde{q}$	$\tilde{q} \to q\chi$	3 parameters
$\tilde{q}\tilde{g}$	$\tilde{q} \to q\chi, \tilde{g} \to q\bar{q}\chi$	4 parameters
$\tilde{g}$	$\tilde{g} \to q\bar{q}\chi', \chi' \to q\bar{q}\chi$	5 parameters
$\tilde{g}$	$\tilde{g} \to q\bar{q}\chi'', \chi'' \to q\bar{q}\chi', \chi' \to q\bar{q}\chi$	7 parameters

• • •

One Cascade


200
150
100
50
0
Bino Mass (GeV)
100
200
300
400
500
Gluino Mass (GeV)
125 GeV

Model Independent Search

For each jet multiplicity

Set a limit on $\dfrac{d^2\sigma}{dH_T d\not{E}_T}\,\Delta H_T\,\Delta \not{E}_T$

e.g.

4 jets

H_T \ $\not{E}_T$	100	200	300
800	<5fb	5^{+2}_{-2}fb	<2fb
600	<10fb	10^{+3}_{-3}fb	<3fb
400	<20fb	10^{+8}_{-8}fb	<5fb
200			

$\not{E}_T$

Tevatron is a proving ground for LHC

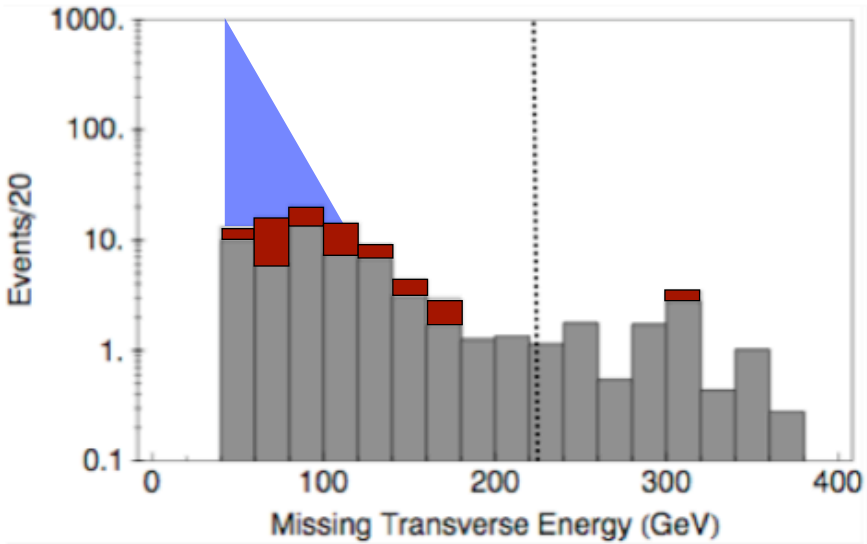
Improvement on existing searches

Need model-independent searches

Important orthogonal directions to mSugra

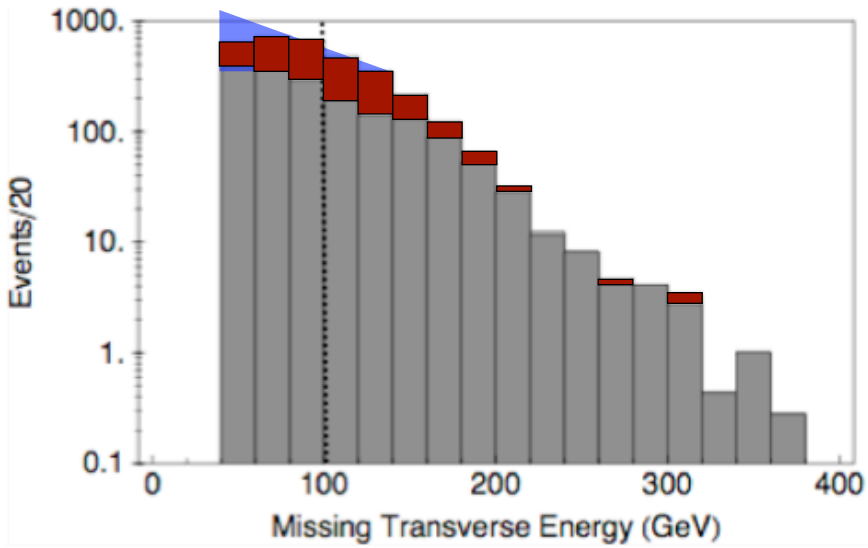
Possible to not discover a visible signal

$m_{\tilde{g}} = 210$ GeV



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

$m_{\tilde{B}} = 100$ GeV



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