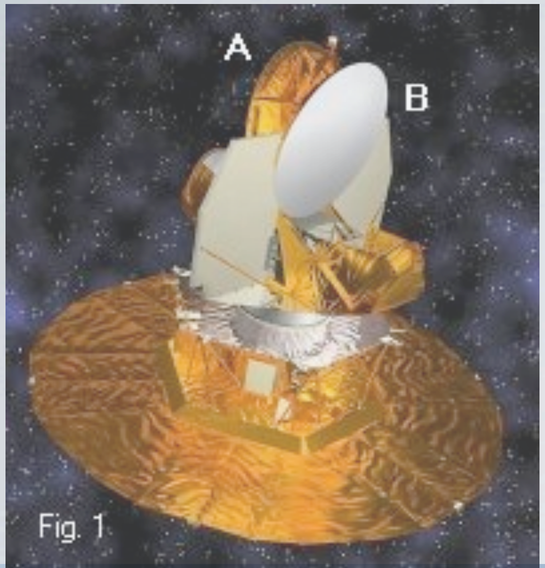
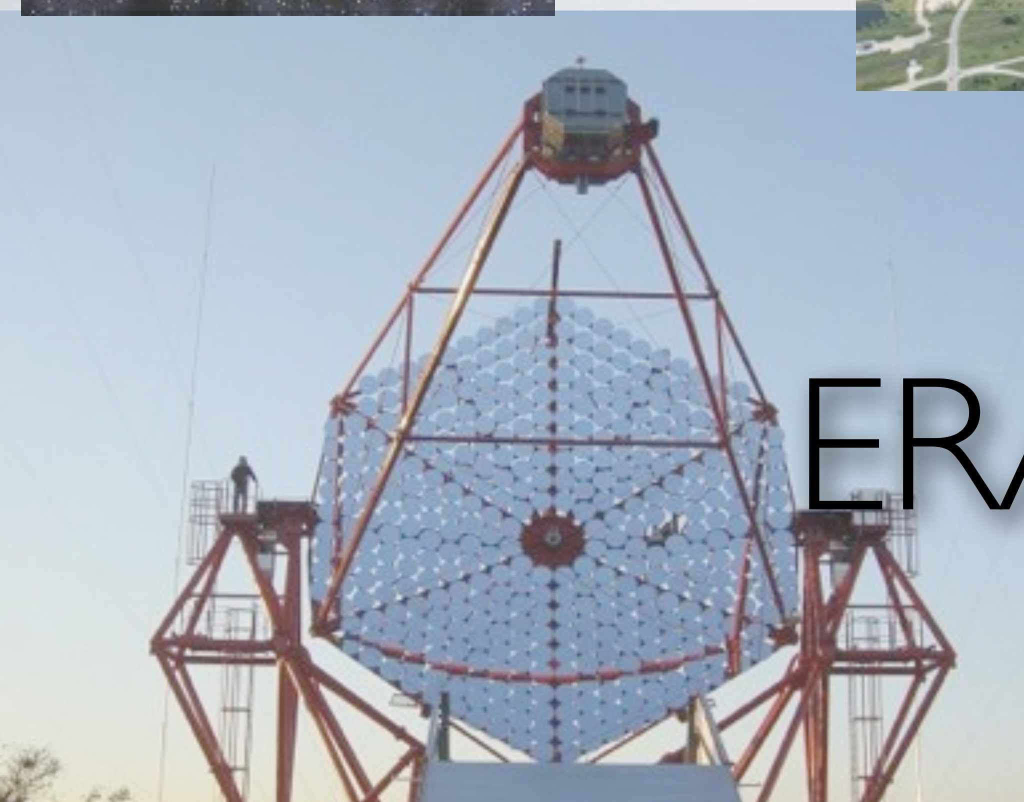
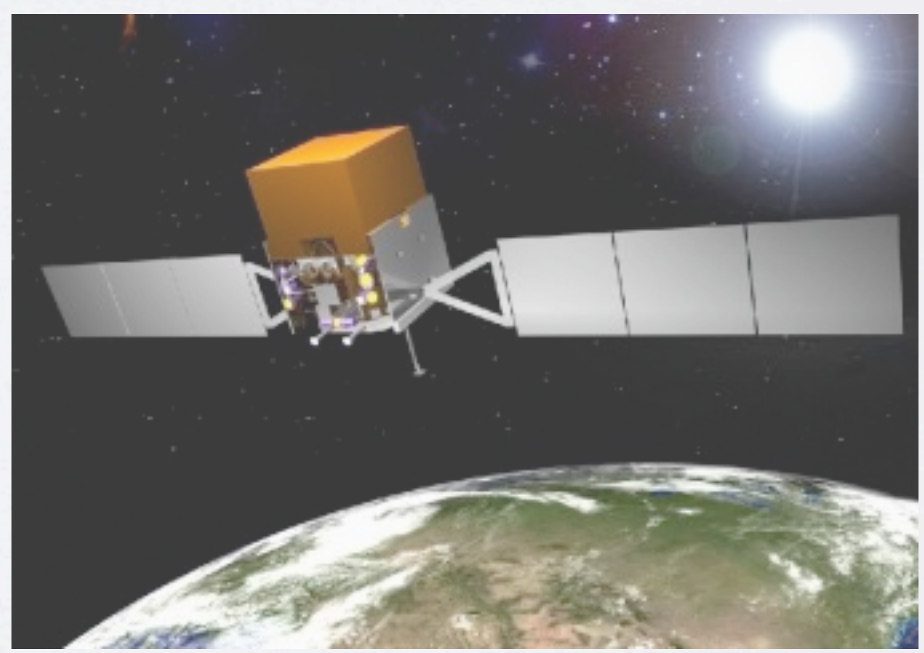
THE ERA OF DATA: A STATUS CHECK

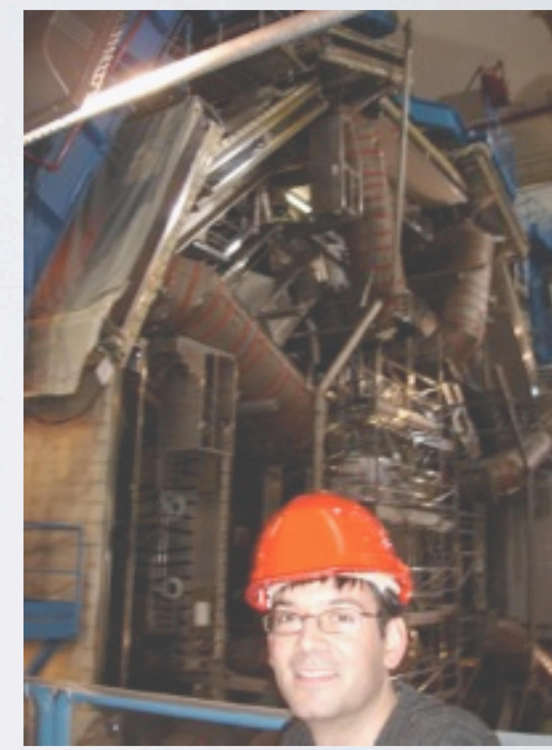
Neal Weiner
NYU

ERA OF DATA







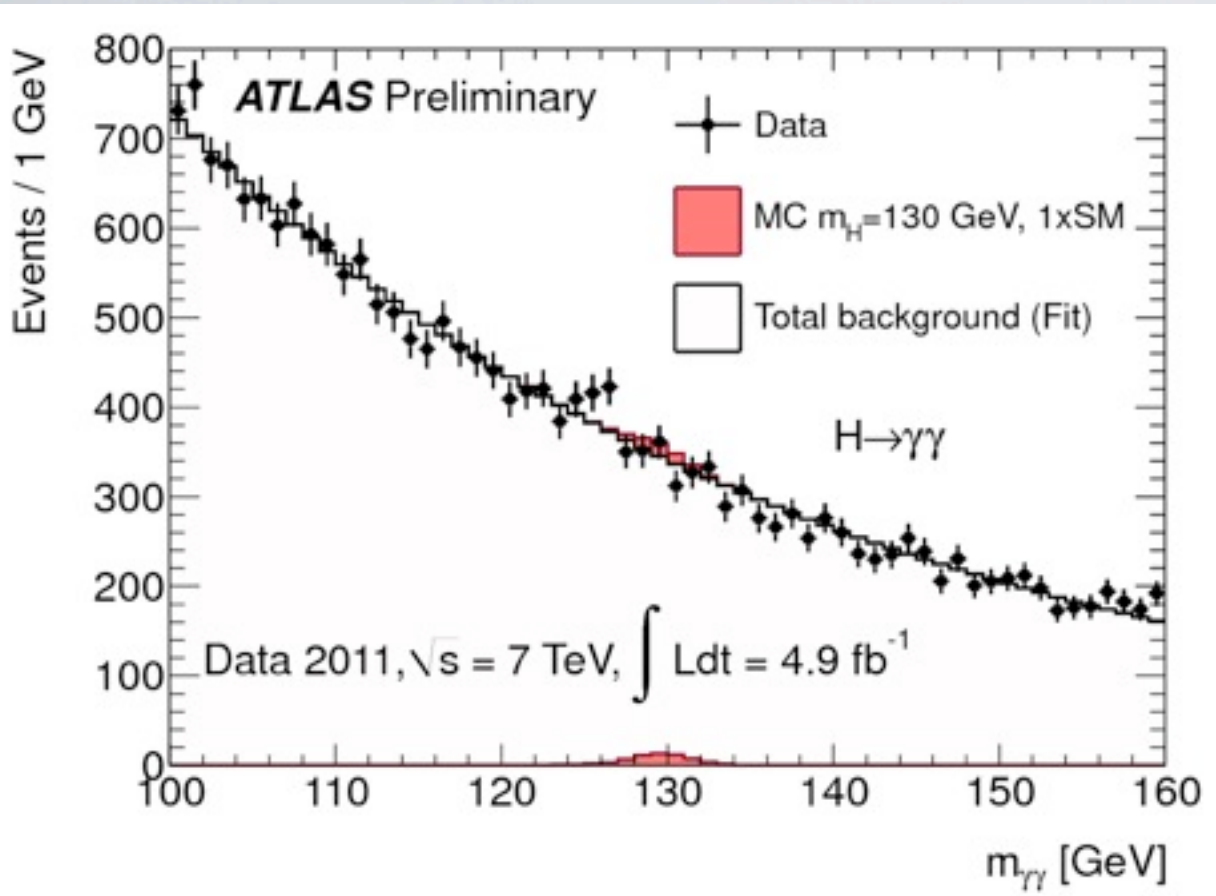


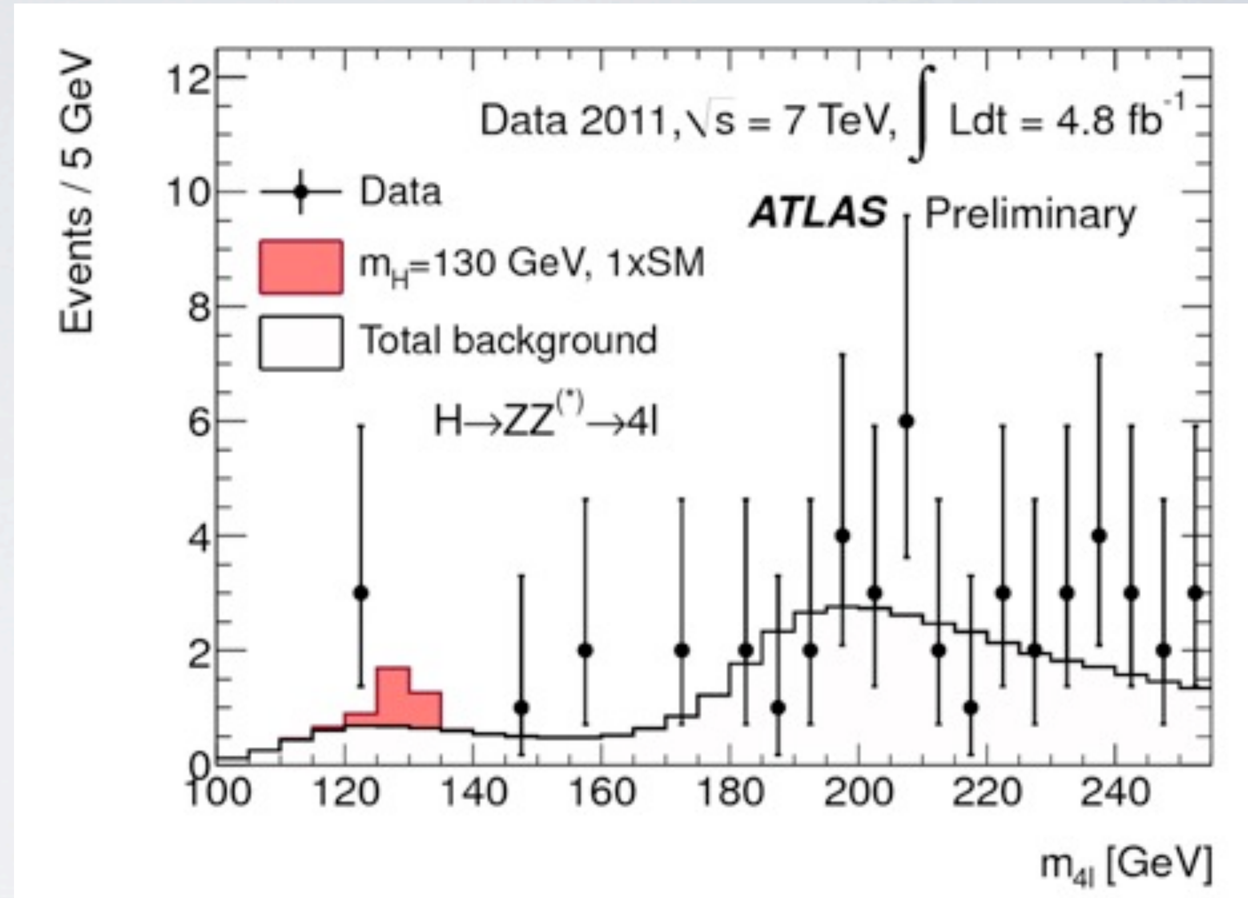
WHAT WE SAID

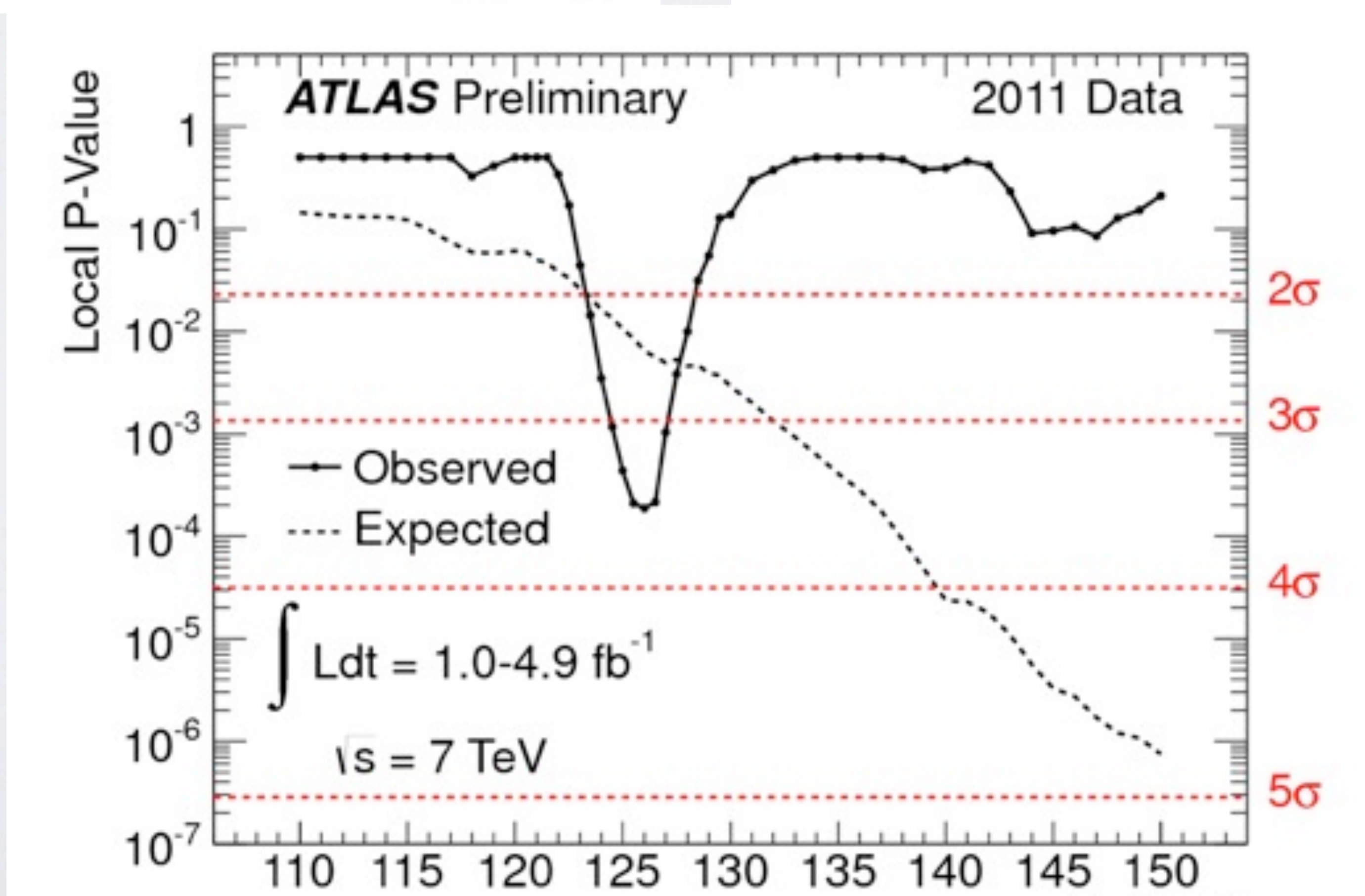
- Data will come in from multiple sources (collider, cosmic ray, direct detection)
- Together they will inform us as to the nature of the weak scale + dark matter
- By reinforcing each other, they will eliminate uncertainties and allow us to make definitive statements

SO WHAT HAPPENED SO FAR?

A HIGGS DISCOVERY?

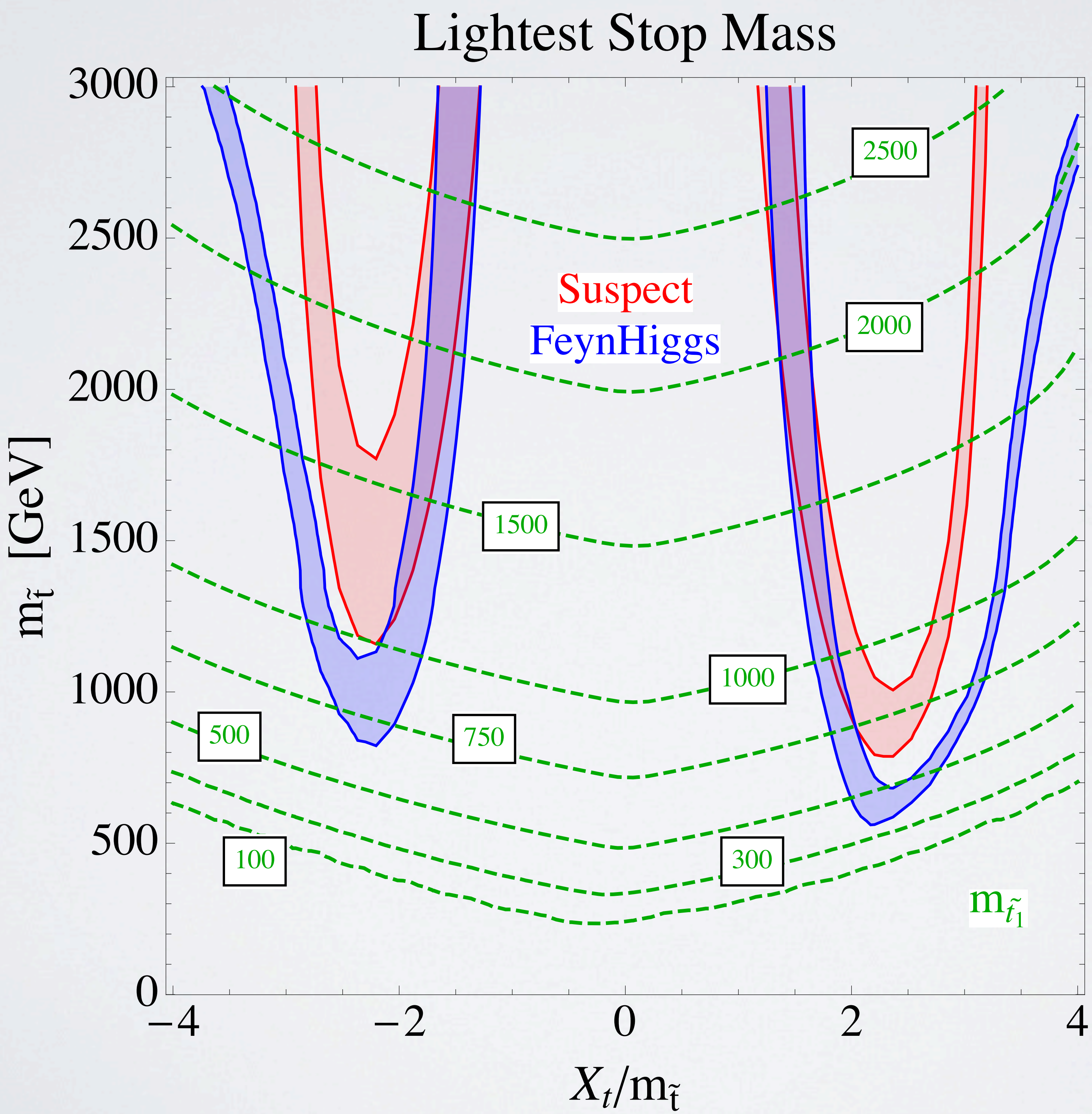




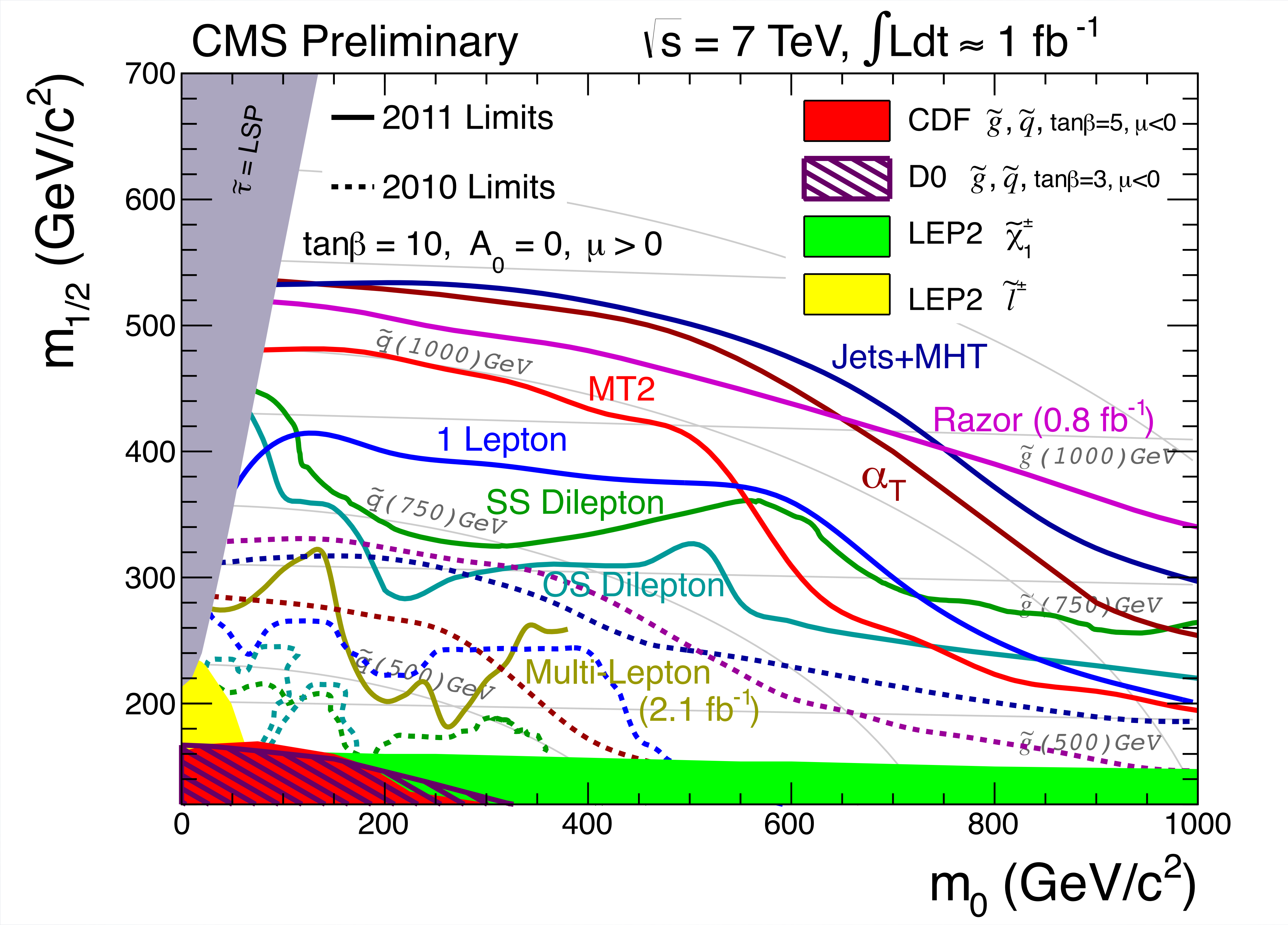


WHAT ABOUT SUSY?

NATURALNESS, SUSY AND THE HIGGS MASS



IT'S NOT A BUG IT'S A FEATURE



SO WHAT DOES THIS TELL US ABOUT SUSY DM?

Implications of a 125 GeV Higgs scalar for LHC SUSY and neutralino dark matter searches

Howard Baer[a], Vernon Barger[b] and Azar Mustafayev[c]

Abstract: The ATLAS and CMS collaborations have reported an excess of events in the $\gamma\gamma$, $ZZ^* \to 4\ell$ and WW^* search channels at an invariant mass $m \simeq 125$ GeV, which could be the first evidence for the long-awaited Higgs boson. We investigate the consequences of requiring $m_h \simeq 125$ GeV in both the mSUGRA and NUHM2 SUSY models. In mSUGRA, large values of trilinear soft breaking parameter $|A_0|$ are required, and universal scalar $m_0 \gtrsim 0.8$ TeV is favored so that we expect squark and slepton masses typically in the multi-TeV range. This typically gives rise to an "effective SUSY" type of sparticle mass spectrum. In this case, we expect gluino pair production as the dominant sparticle creation reaction at LHC. For $m_0 \lesssim 5$ TeV, the superpotential parameter $\mu \gtrsim 2$ TeV and $m_A \gtrsim 0.8$ TeV, greatly restricting neutralino annihilation mechanisms. These latter conclusions are softened if $m_0 \sim 10 - 20$ TeV or if one proceeds to the NUHM2 model. The standard neutralino abundance tends to be far above WMAP-measured values unless the neutralino is higgsino-like. We remark upon possible non-standard (but perhaps more attractive) cosmological scenarios which can bring the predicted dark matter abundance into accord with the measured value, and discuss the implications for direct and indirect detection of neutralino cold dark matter.

NATURALNESS, SUSY, HIGGS MASS AND DARK MATTER

Higgs at 125 ⇒ large $m^2_{\tilde{u}}, m^2_{\tilde{q}}$

⇓

large corrections to $m^2_{H_u}$

⇓

Cancel with large μ term

⇓

Higgsino is heavy

⇓

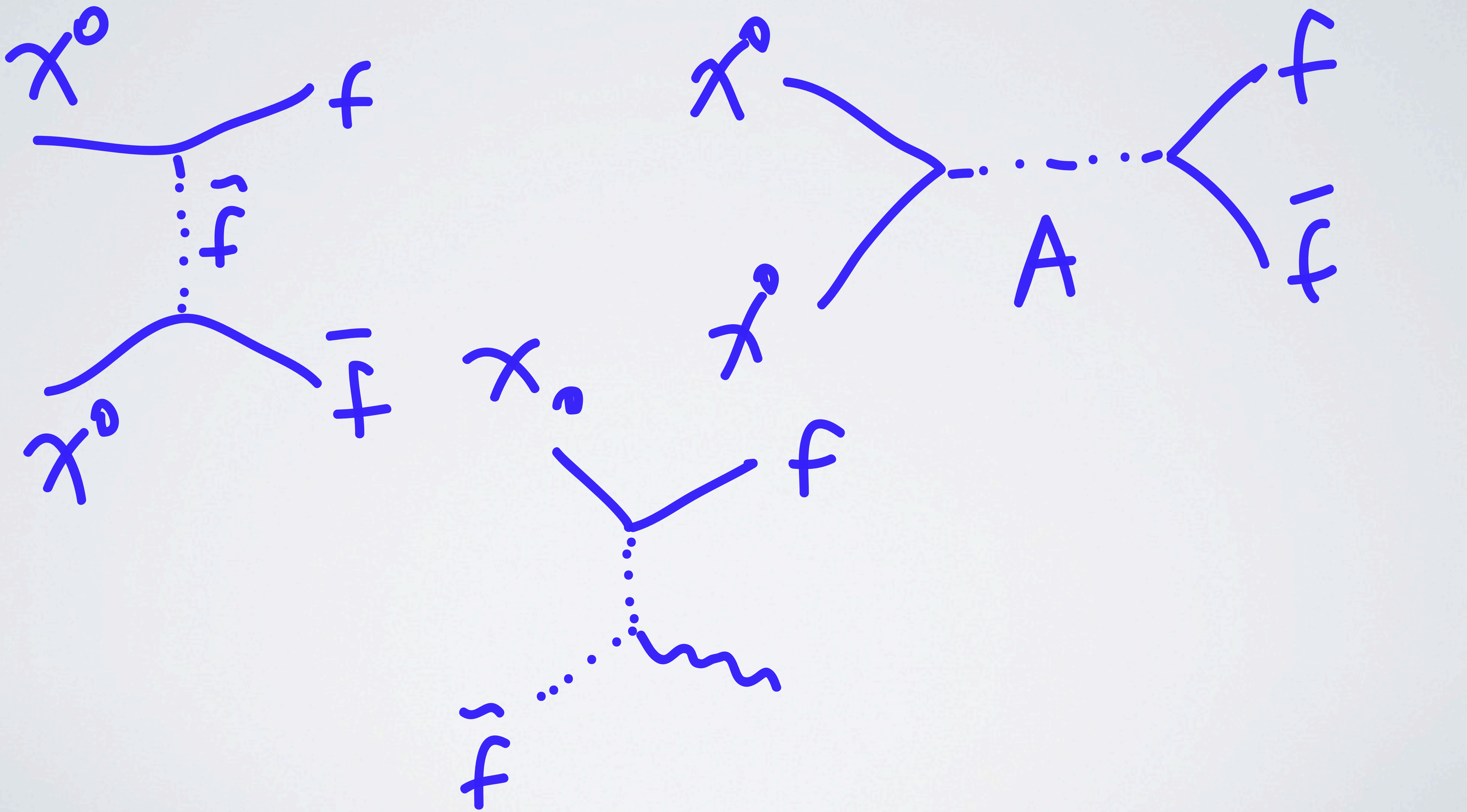
LSP is Bino ⇒ Bino is weakly coupled

⇓

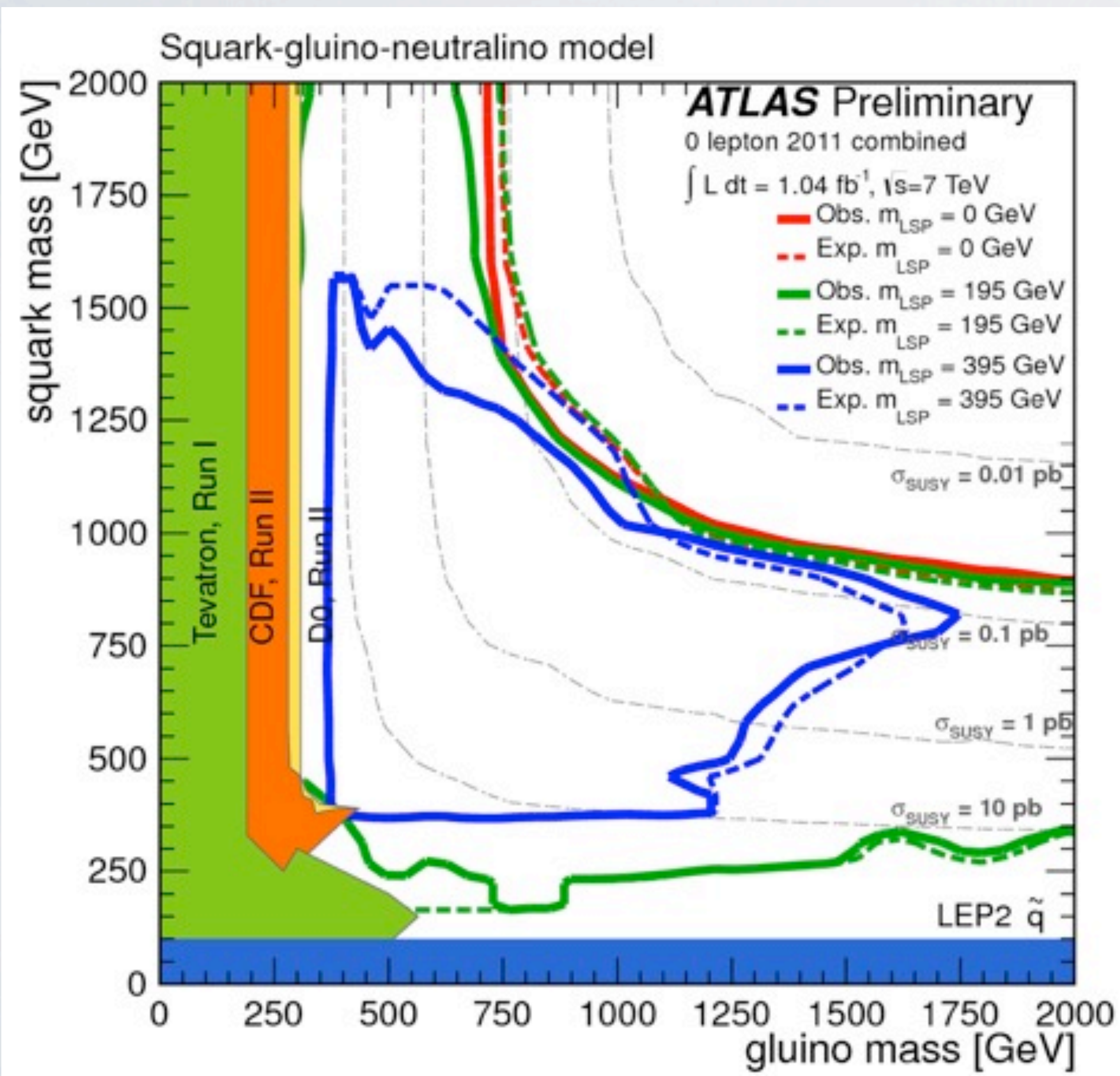
need tuned scenarios

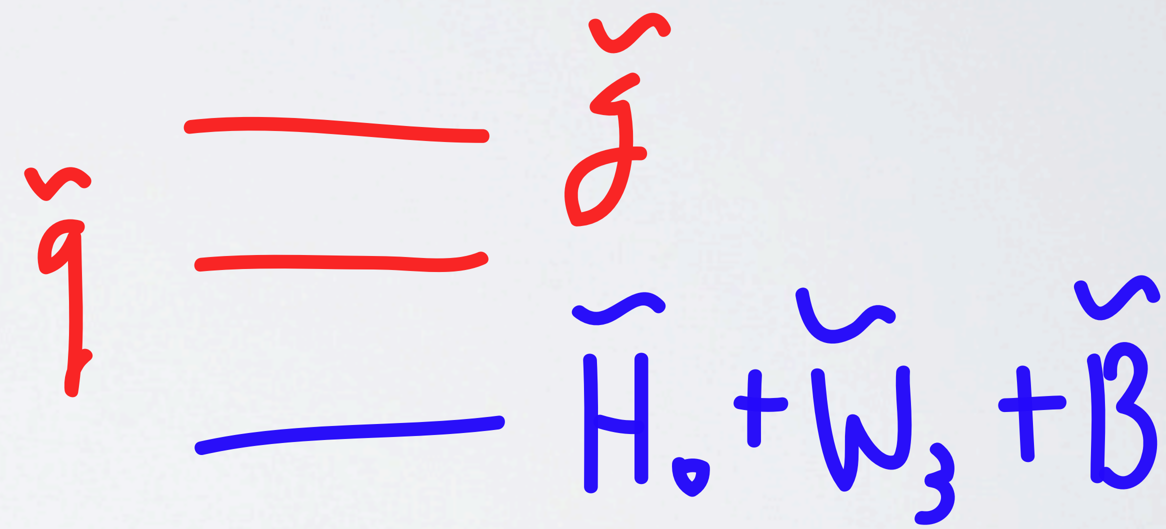
WHAT IS SUSY DM

- A singlet, a doublet and a triplet with some specific couplings



MAYBE IT'S NOT ALL THAT BAD





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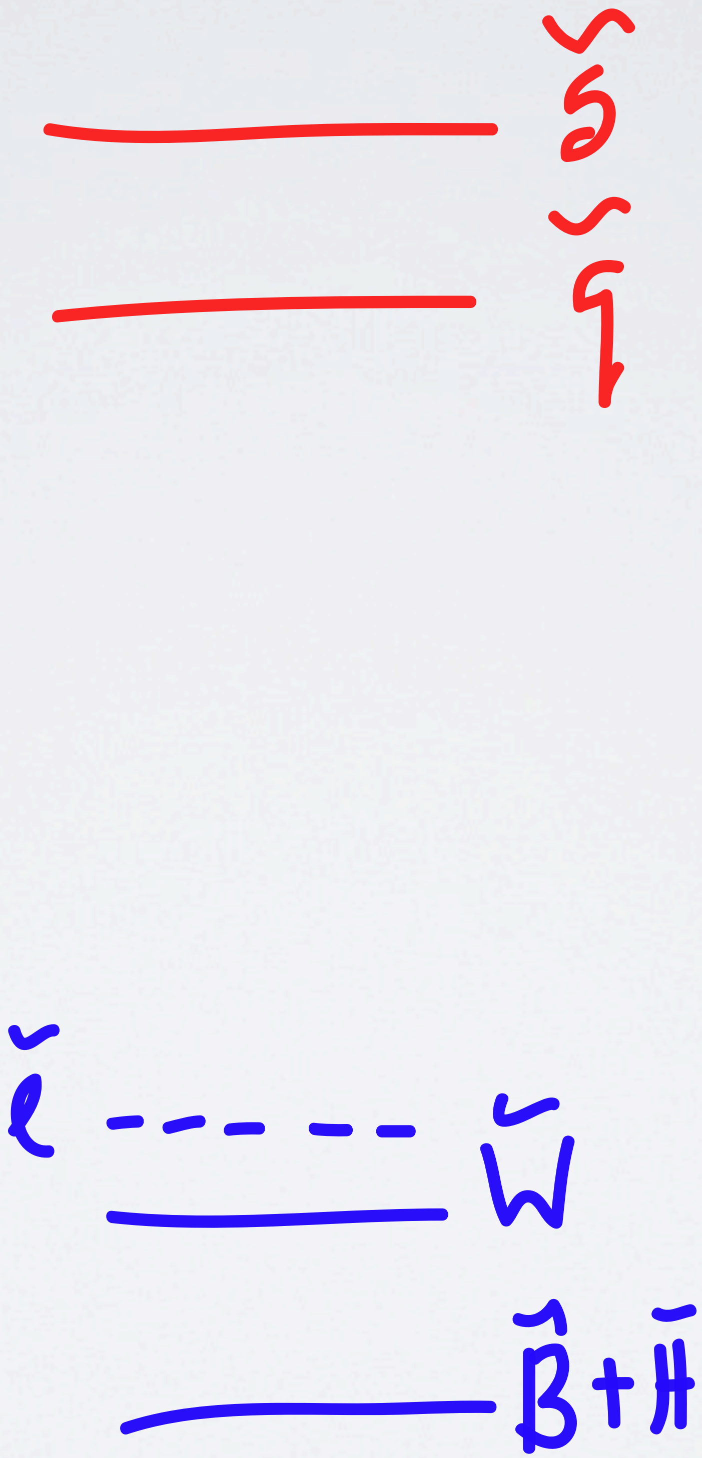

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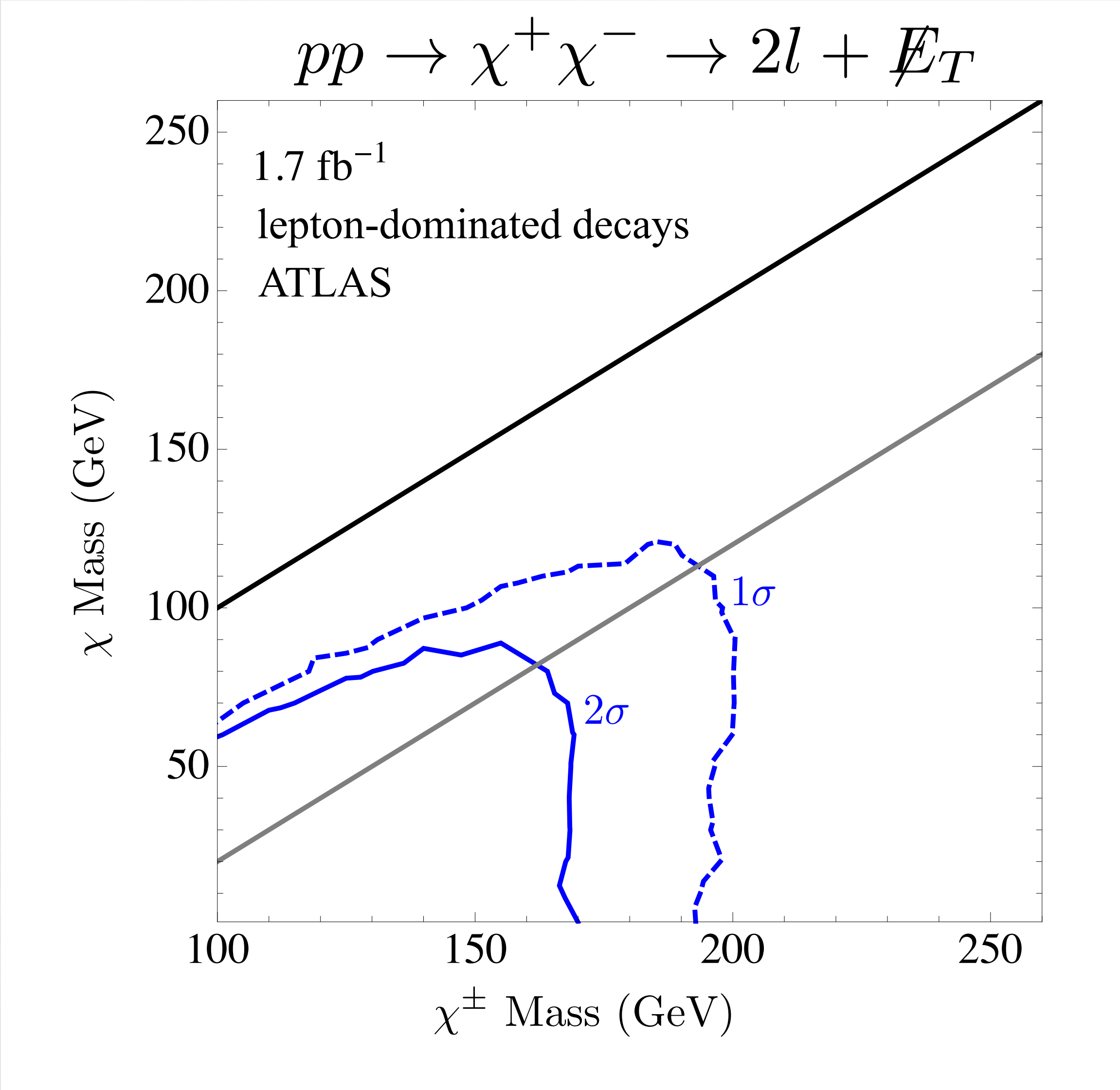
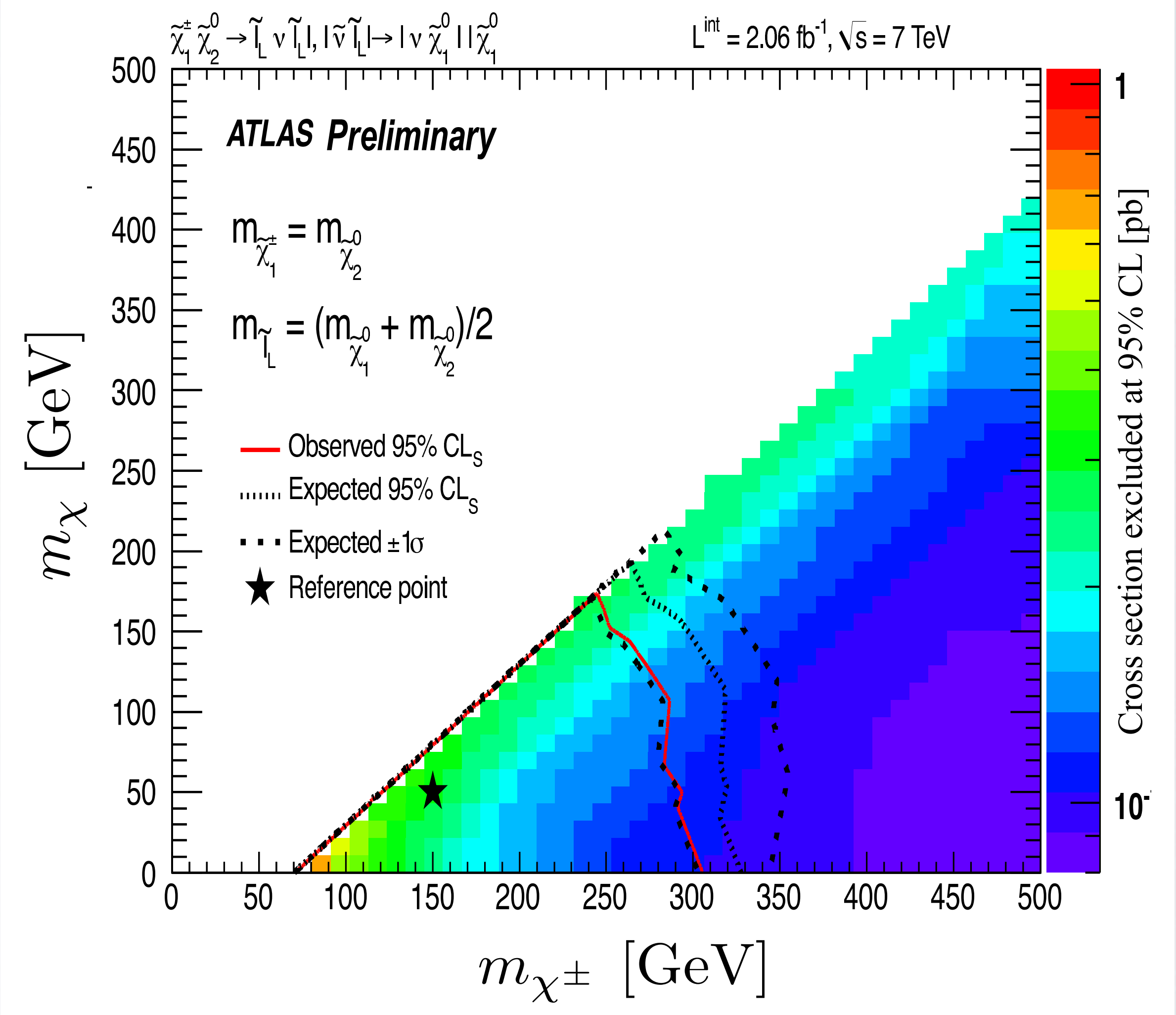


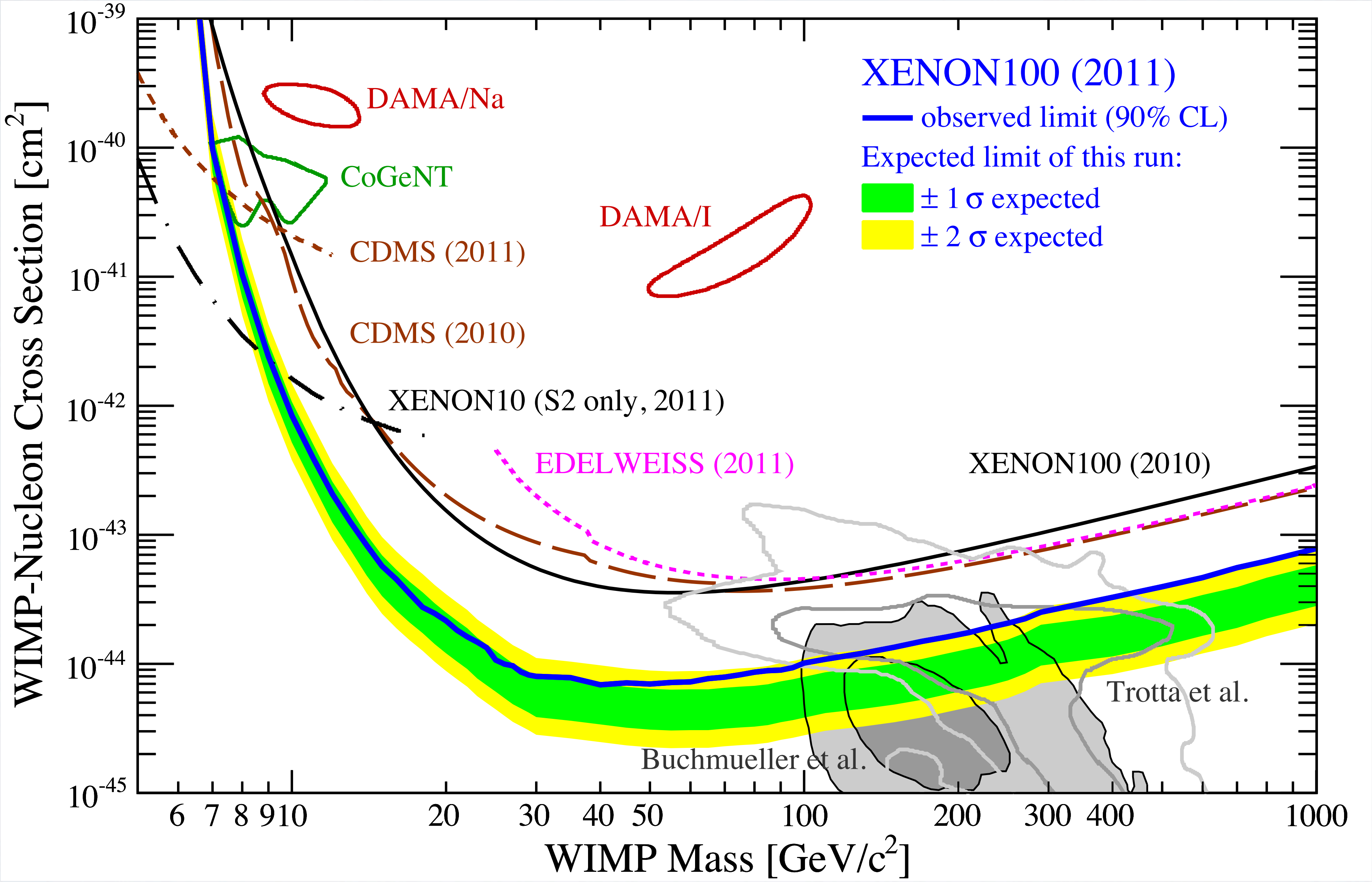


ATLAS-CONF-2012-023

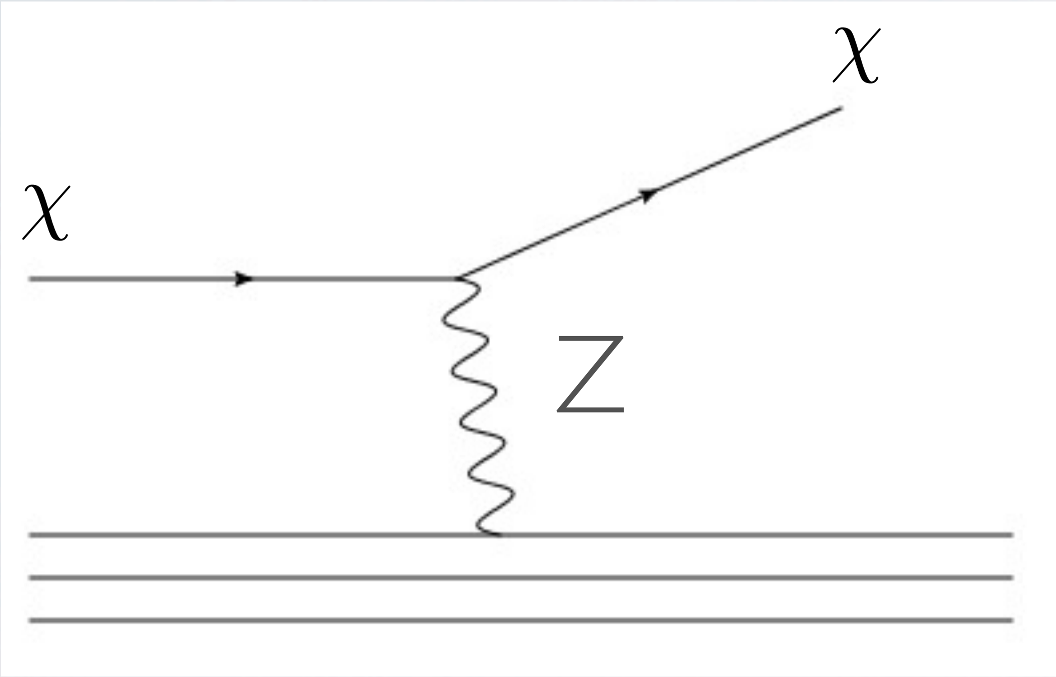
WHAT DOES THE LHC TELL US SO FAR

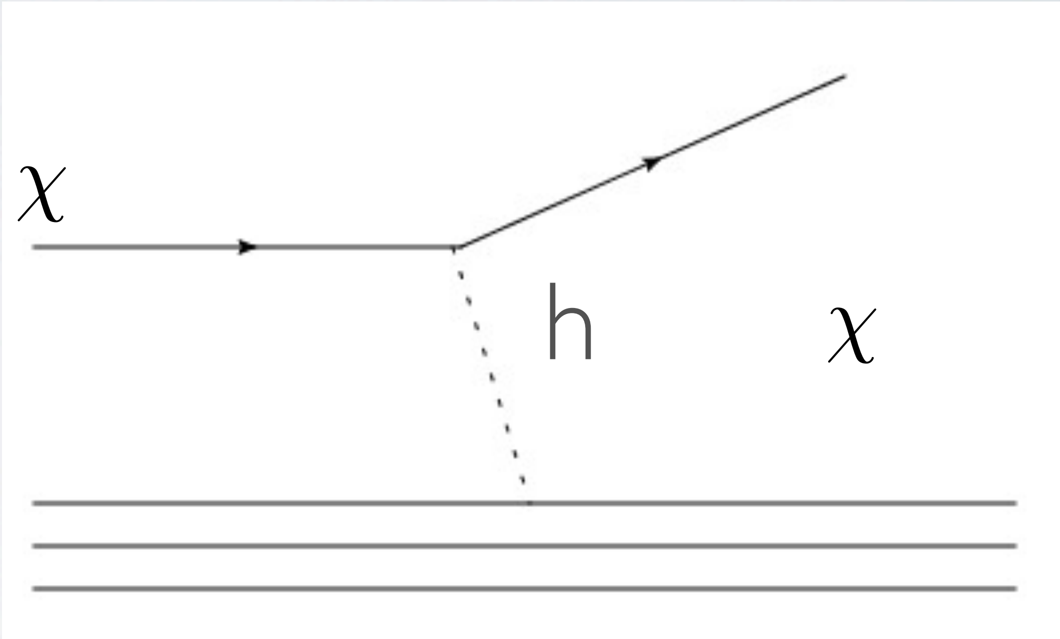
- If DM has colored partners, they are either pretty close or very far in mass from the WIMP
- Cascades do not produce a lot of leptons (if through colored initial states)

DIRECT DETECTION AND A CONVENTIONAL WIMP



THE TWO CROSS SECTIONS TO THINK ABOUT





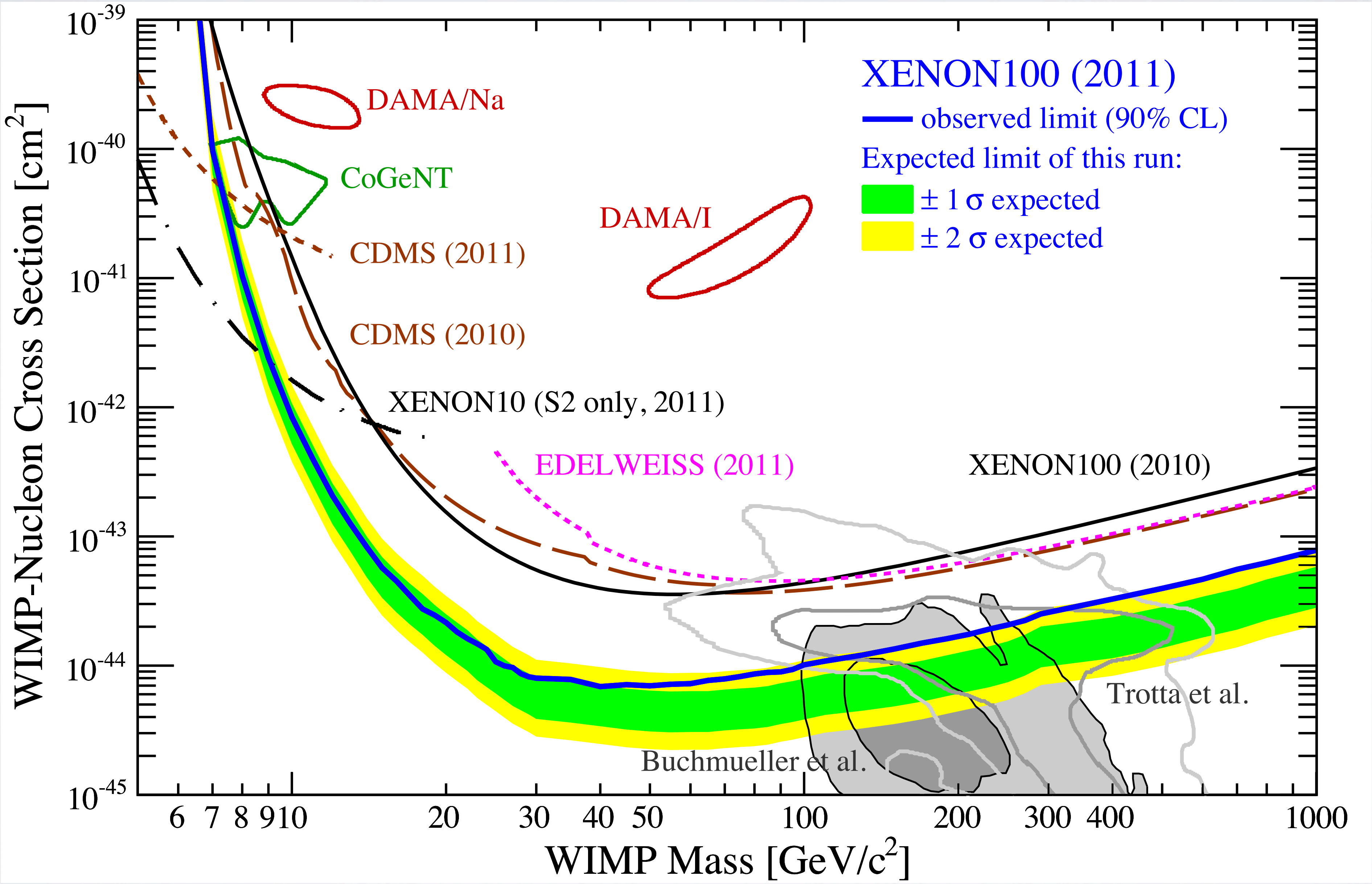
$$\sigma_0 \approx \frac{G_f^2 \mu^2}{2\pi} \sim 10^{-39}\text{cm}^2$$

$$g \sim 1 \Rightarrow y_p \sim \frac{1}{\text{few}} \frac{m_p}{v}$$

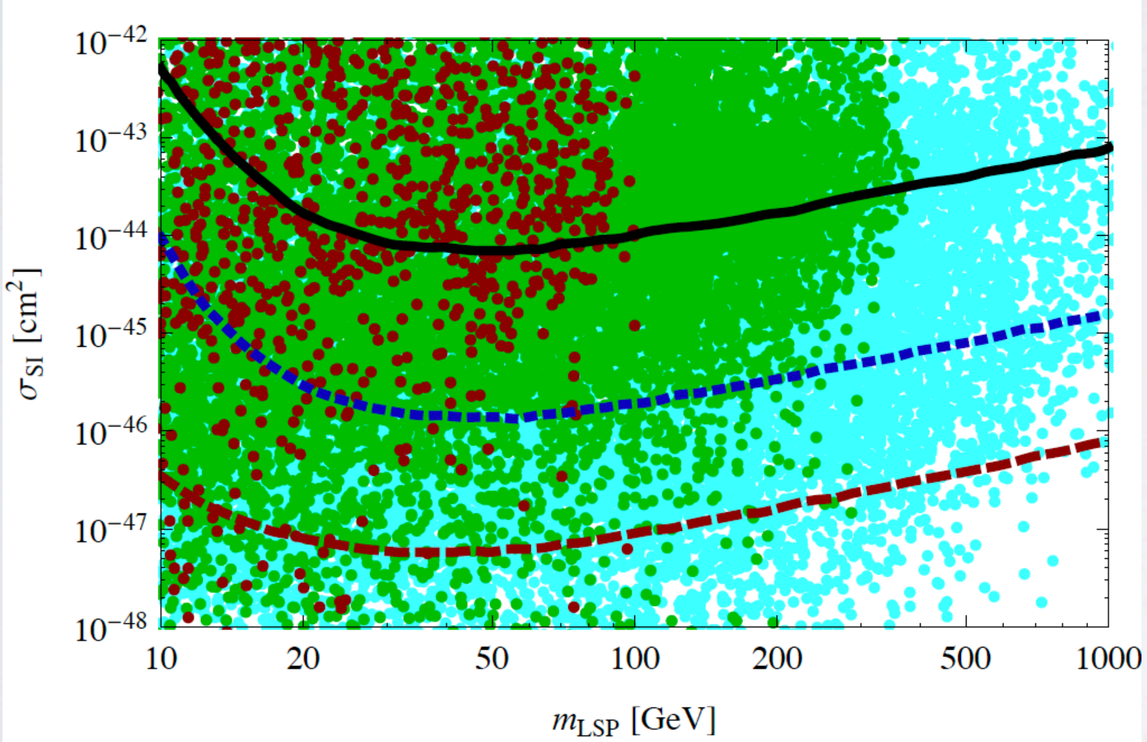
$$\sigma_0 \sim 10^{-39}\text{cm}^2 \times 10^{-6}$$

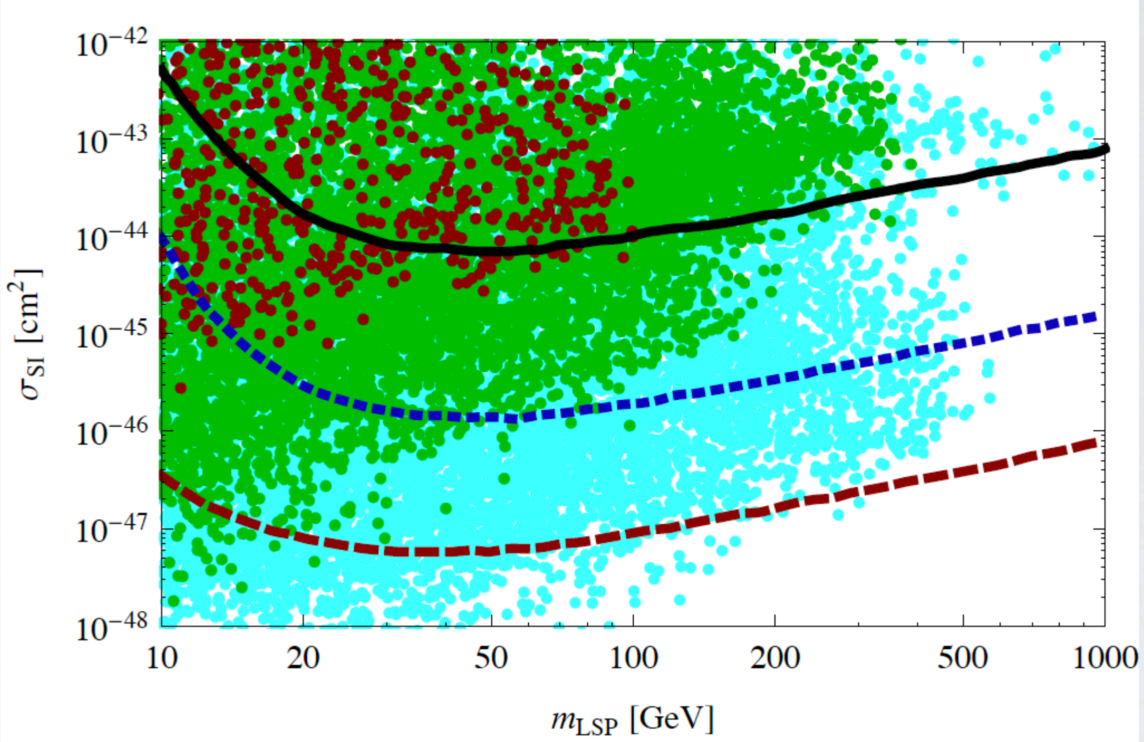
$$\sim 10^{-45}\text{cm}^2$$

DIRECT DETECTION AND A CONVENTIONAL WIMP



DIRECT DETECTION AND SUSY DM





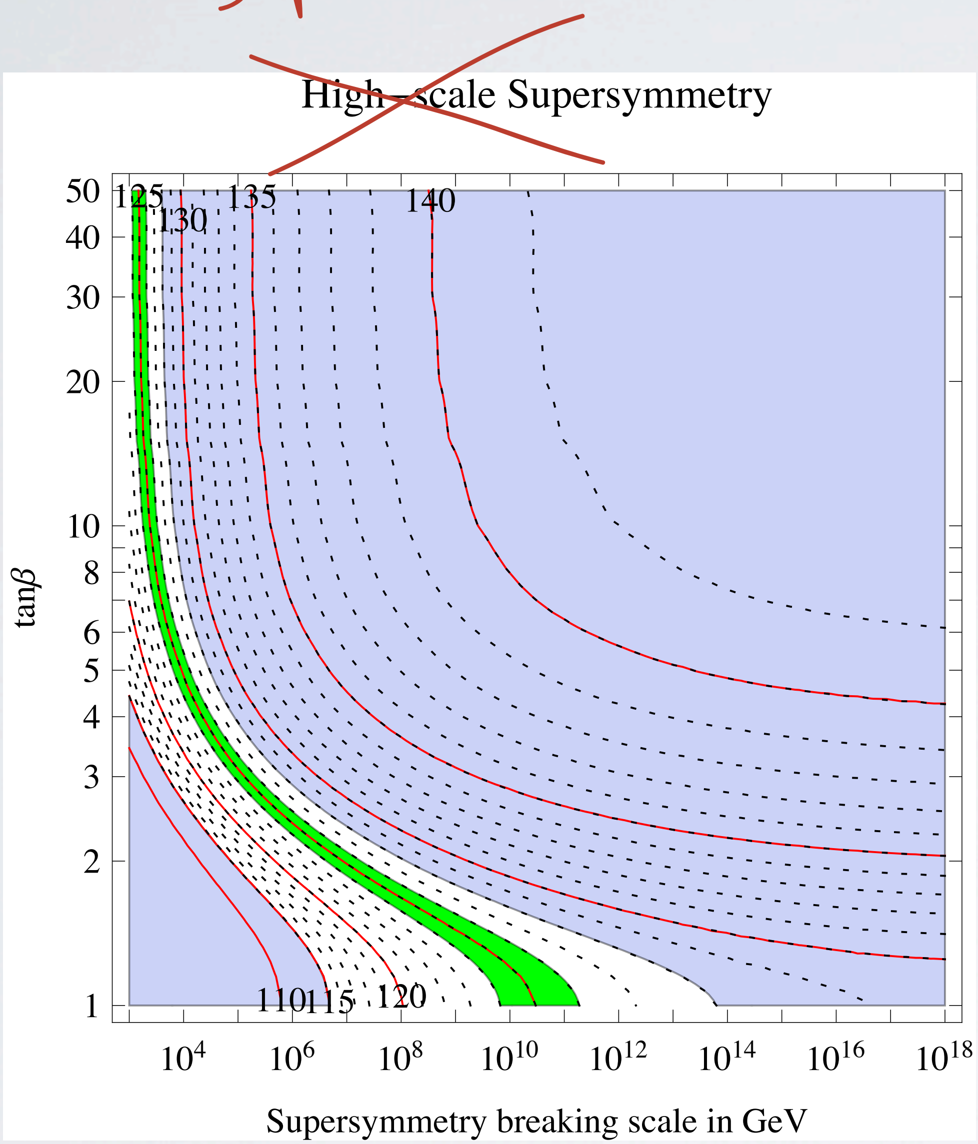
Perelstein + Shukya '11

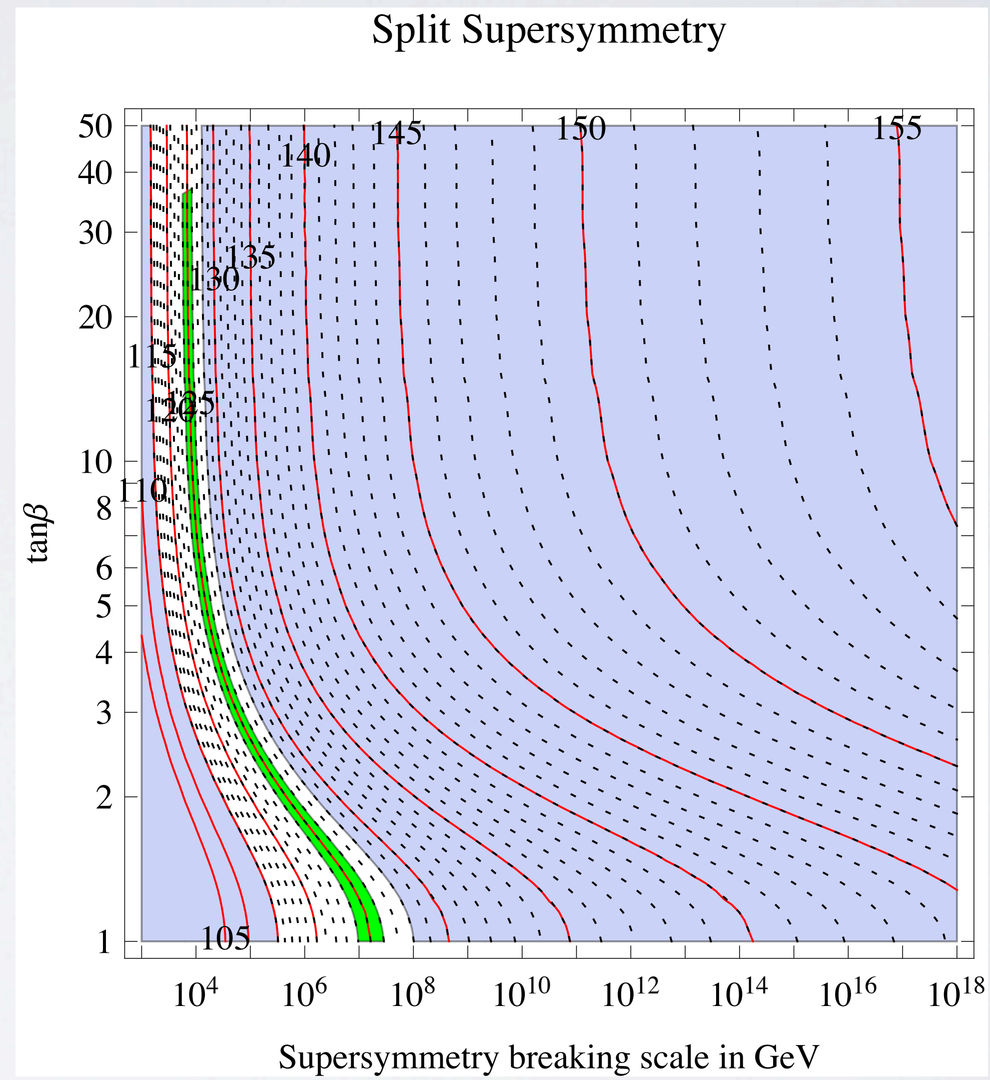
LSP DARK MATTER

- If you tune your initial conditions (e.g. CMSSM) LSP WIMPs are often tuned
- If you give up on preconceived notions of unified soft breaking parameters (“chaotic SUSY”), LSP dark matter is pretty easy
- Direct detection is cutting into standard WIMP parameter space
- Finely tuned WIMPs can survive... a long time

IMPLICATIONS FOR SUSY SPECTRA

supersplit





Giudice + Strumia

JUST GO WITH IT

A SIMPLE, UNNATURAL SCENARIO

- So SUSY looks tuned
  - 1%, .1%, something
- So maybe we just embrace that
- Q: What is the nicest scenario modulo this?

A SIMPLE, UNNATURAL SCENARIO

- Usual approach to SUSY breaking

$$\int d^4\theta\, X^\dagger X\, Q^\dagger Q \Rightarrow m_{\tilde{q}}^2$$

$$\int d^2\theta\, X W_\alpha W^\alpha \Rightarrow m_\lambda \lambda\lambda$$

$$\langle X \rangle = \theta^2 F$$

X is a pure singlet!

A SIMPLE, UNNATURAL SCENARIO

- Anomaly mediated SUSY breaking

$$\int d^4\theta\, X^\dagger X\, Q^\dagger Q \Rightarrow m_{\tilde{q}}^2$$

$$m_\chi = \frac{g^2}{16\pi^2} b_{eff}\, m_{3/2}$$

Separation of ~ 100 between scalars and inos

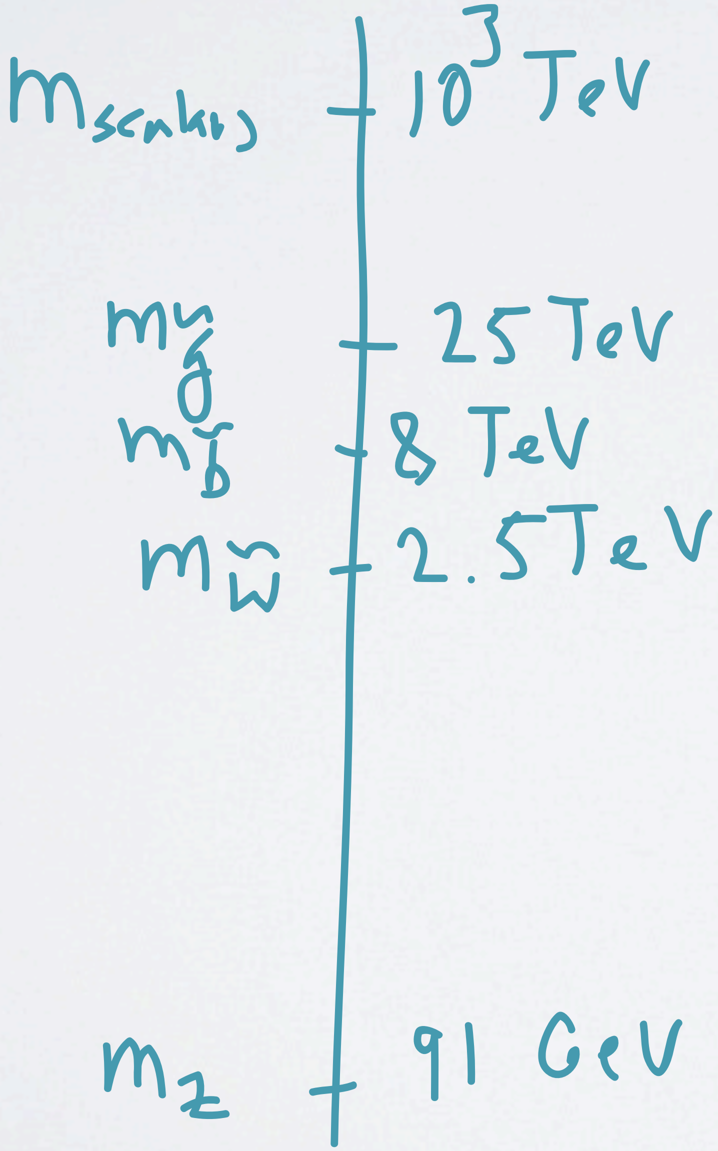
so what sets the scale?

DARK MATTER

- The LSP generically (but not exclusively) the Wino
- To be DM *or not overclose the universe* mW<2.5 TeV

THE SPECTRUM

a "natural" spectrum



There are a lot of nice things about this spectrum

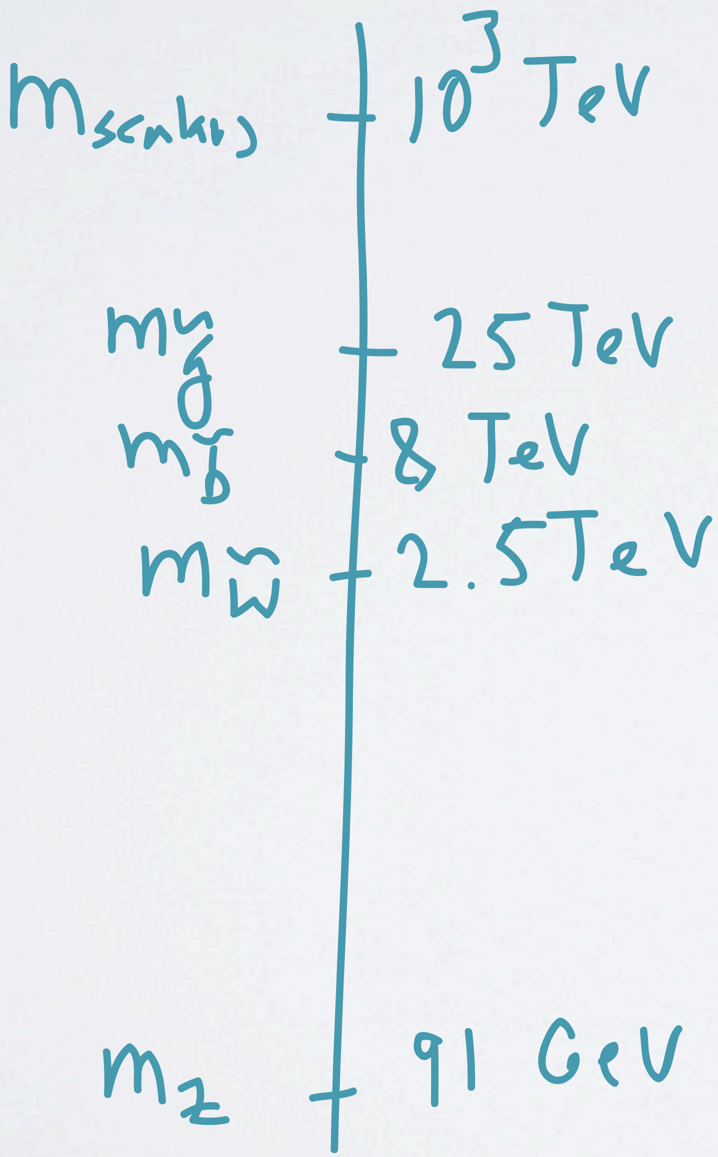
1) b-tau unification works nicely

2) flavor becomes a non-issue for SUSY

3) it's consistent with our non-observation of SUSY so far

THE SPECTRUM

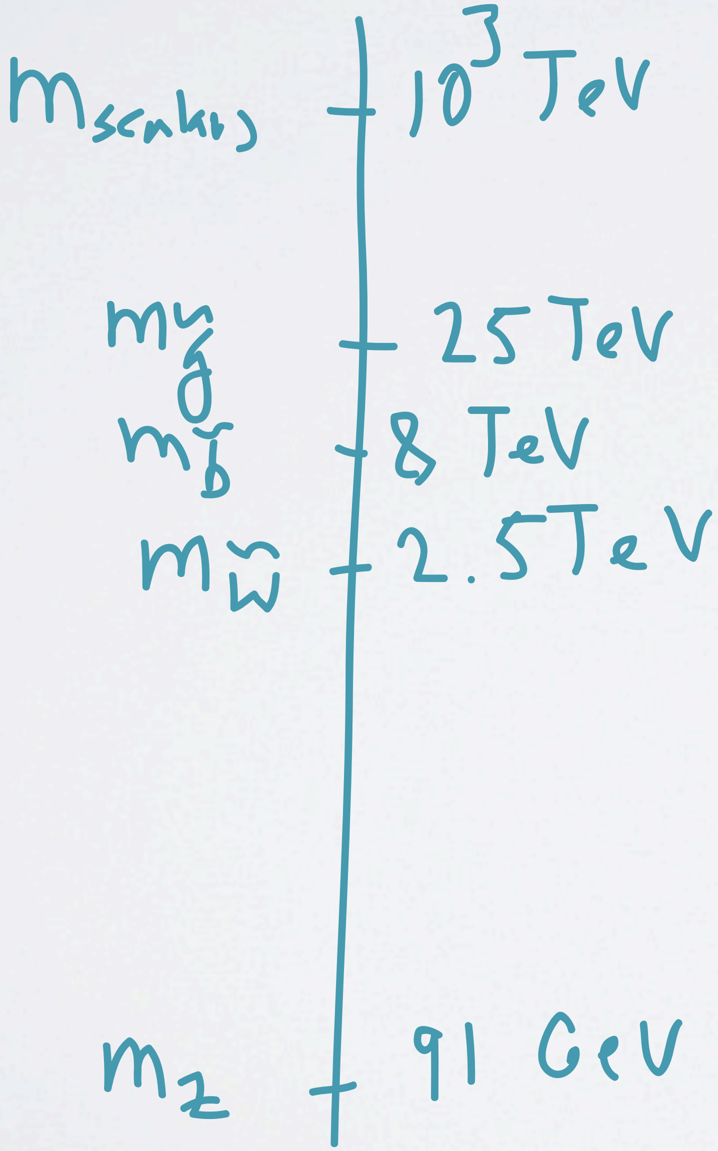
a "natural" spectrum



But this spectrum will not be discovered at the LHC

THE SPECTRUM

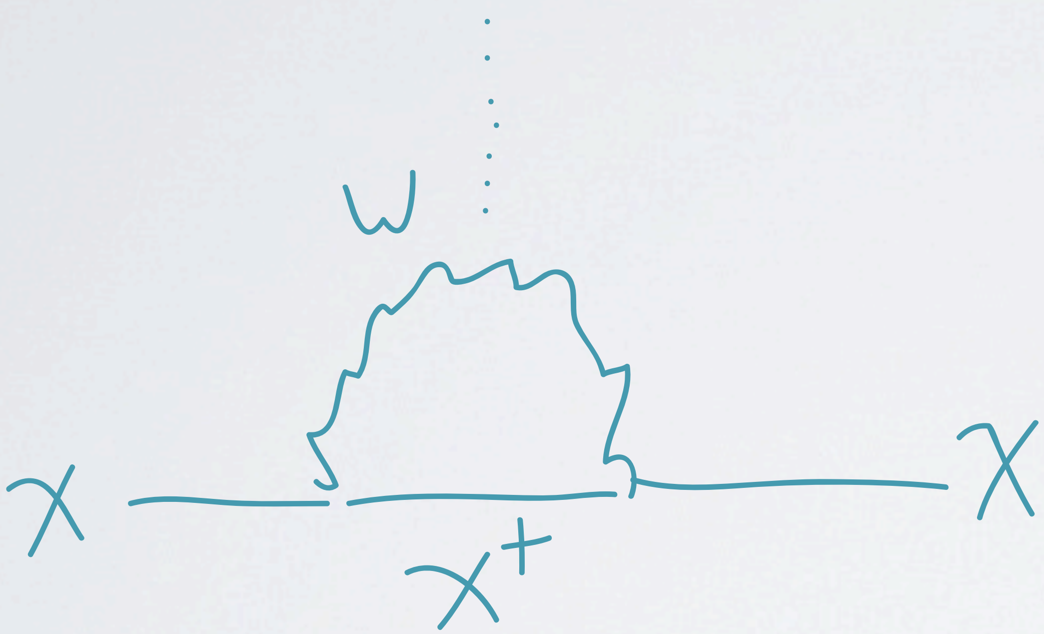
a "natural" spectrum

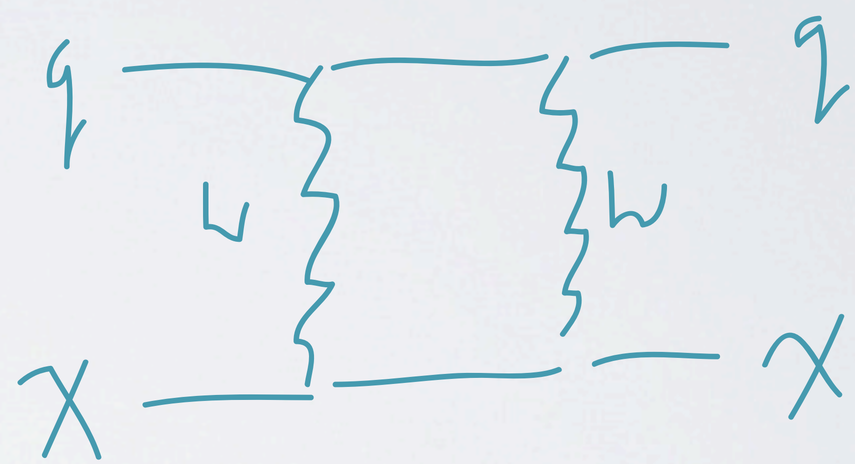


Are we hosed?

A NIGHTMARE SCENARIO?

- Direct detection: Triplet (Wino) has **no** coupling to Z, **no** tree level coupling to Higgs

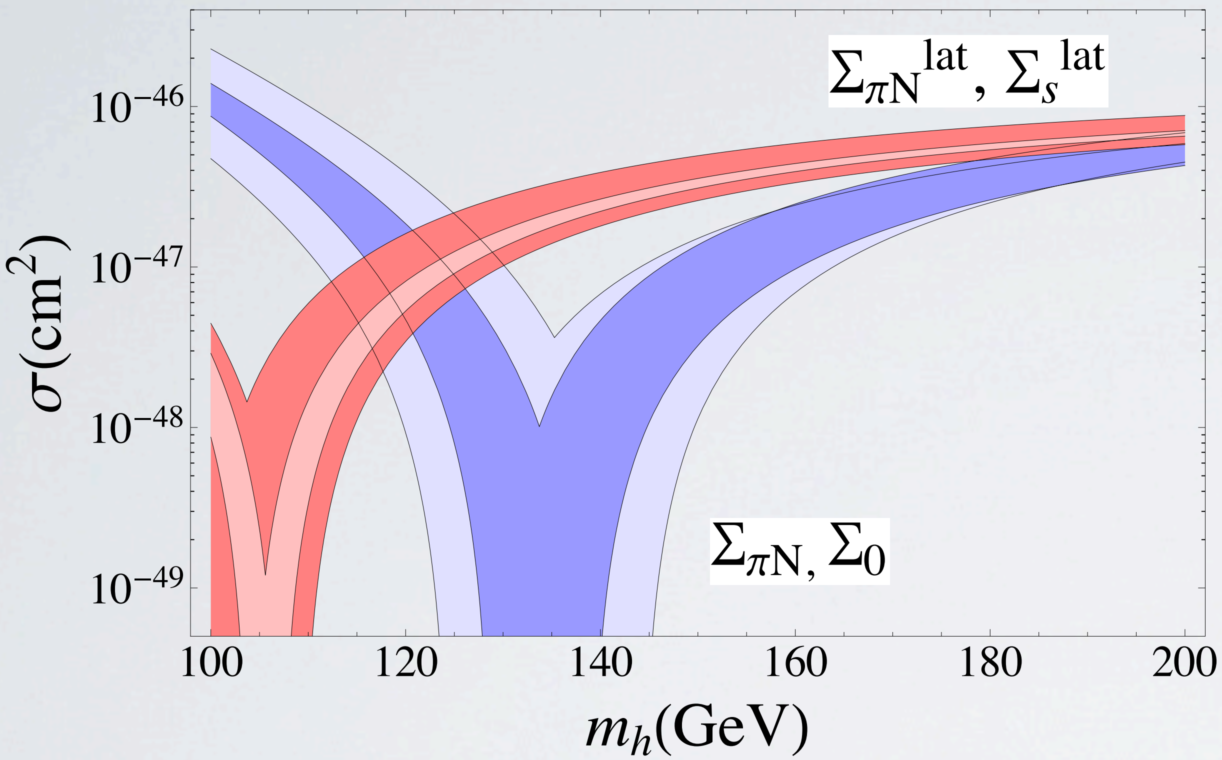




$$\sigma_n \sim 10^{-45}\ cm^2$$

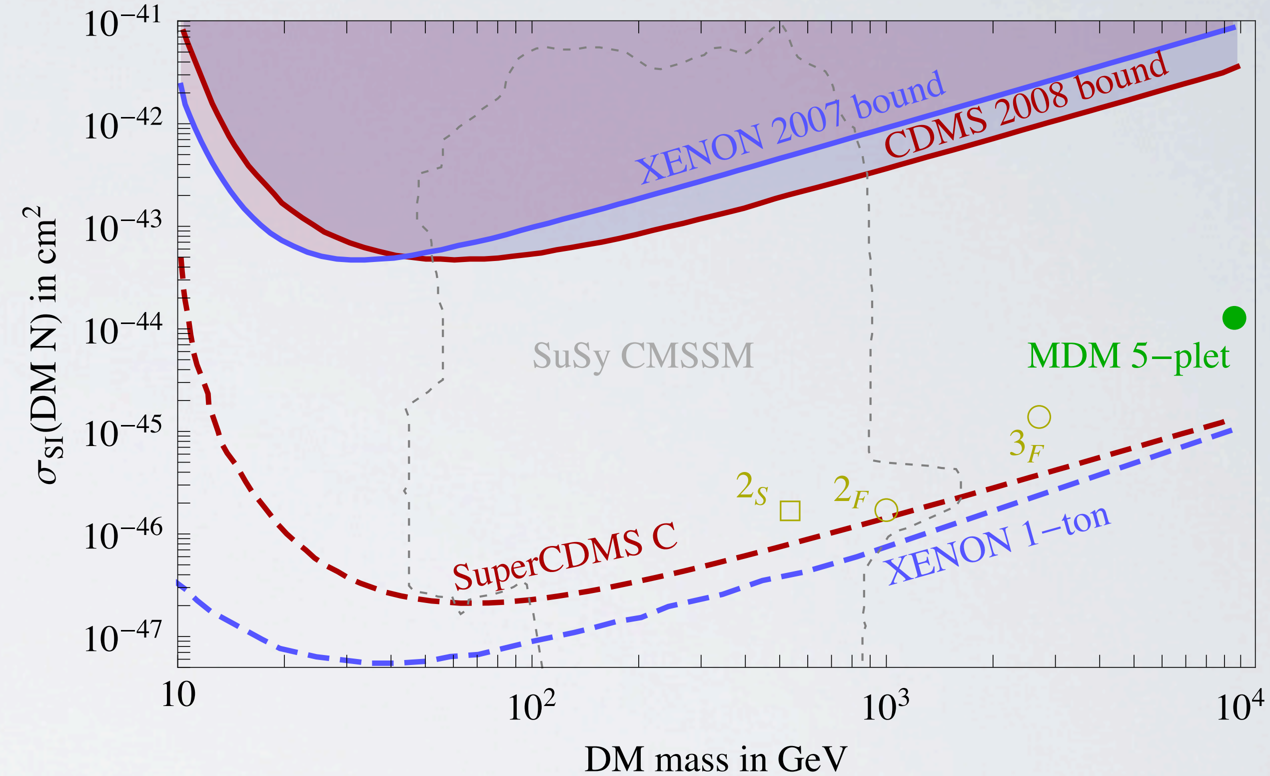
Nojiri et al; Cirelli + Strumia

A CONFUSION?



Hill & Solon '11

scalar

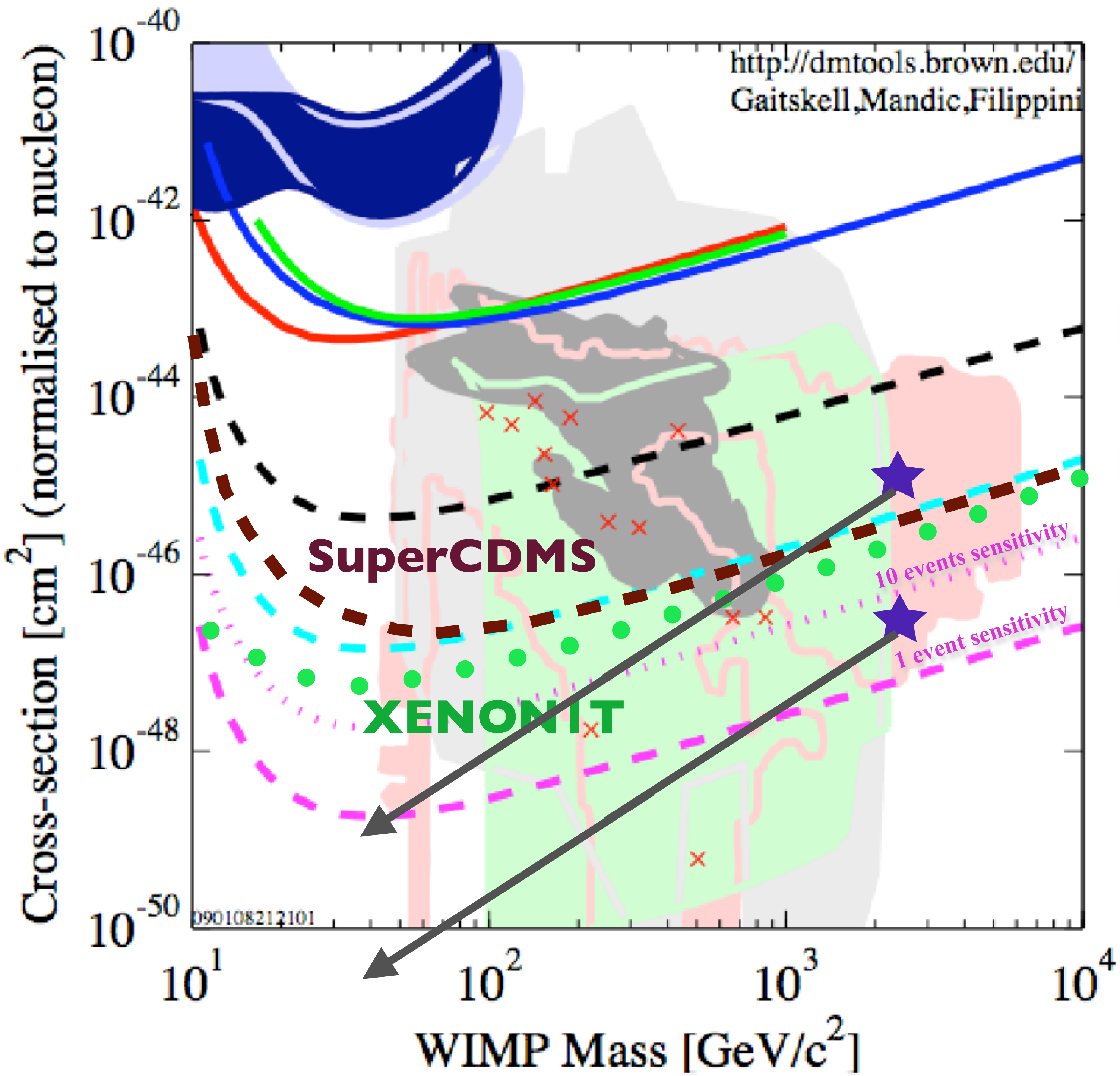


$$\sigma_{\rm SI}({\rm DM}\,\mathcal{N}\to{\rm DM}\,\mathcal{N}) = (n^2-1)^2\frac{\pi\alpha_2^4 M_{\mathcal{N}}^4 f^2}{64 M_W^2}\left(\frac{1}{M_W^2}+\frac{1}{m_h^2}\right)^2$$

Cirelli & Strumia '09

fermion

A NIGHTMARE SCENARIO?



- Projections based on
  - Known background levels
  - Previously obtained e$^-$ attenuation lengths and discrimination factors

LUX (constr: 2008-2009, ops: 2010-2011)
100 kg x 300 days

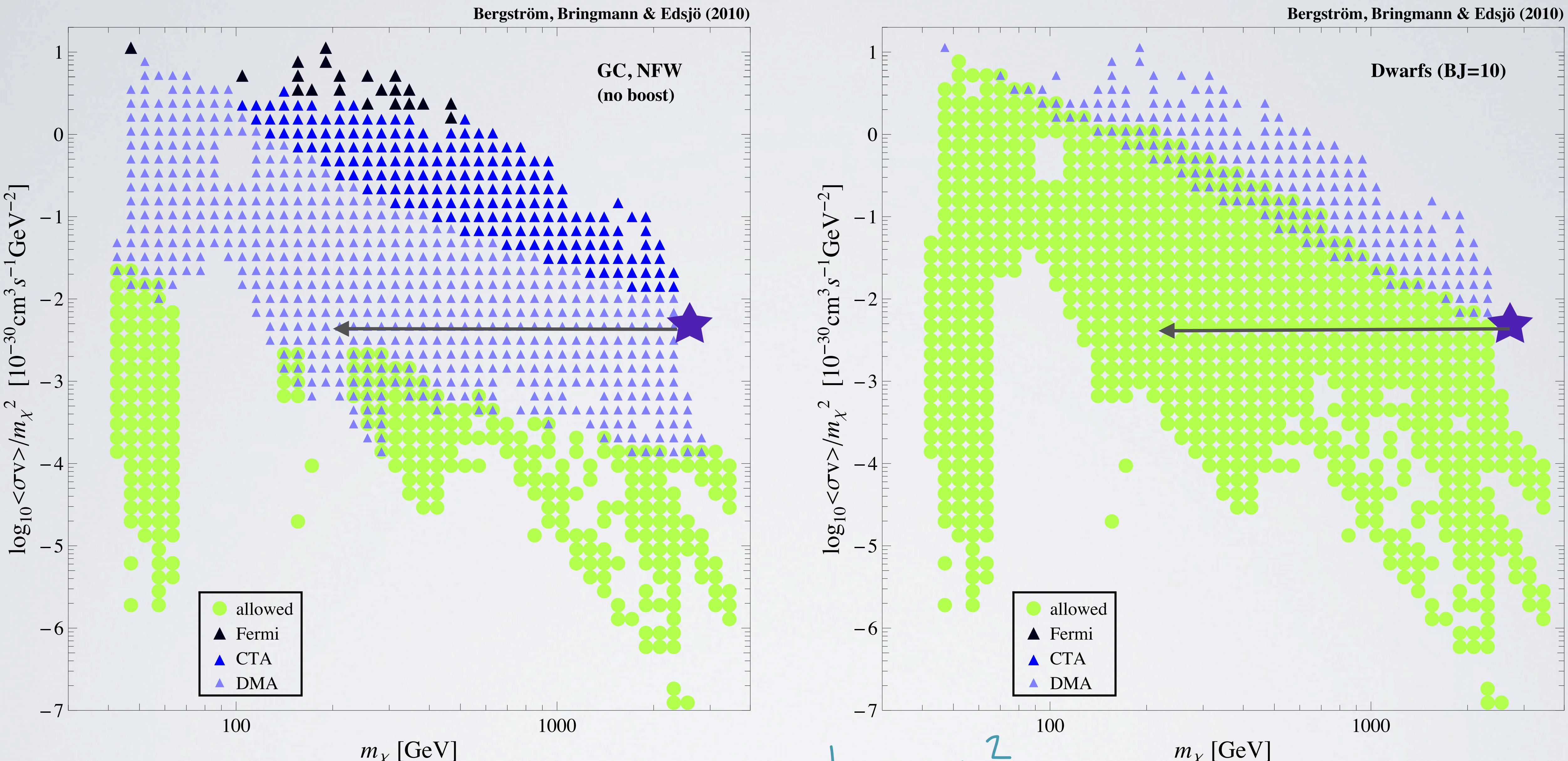
LZ3 (constr: 2010-2011, ops: 2012-2013)
1,500 kg x 500 days

LZ20 (constr: 2013-2015, ops: 2016-2019)
13,500 kg x 1,000 days

- Fiducial volumes selected to match < 1 NR event in full exposure

$$\sigma_0 \rho \sim \sigma_0 \rho_0 \left(\frac{2.5\,\text{TeV}}{m_\chi}\right)^2$$

INDIRECT HANDLES



$\sigma \sim \frac{1}{m_\chi^2}$ $\quad \rho \sim \frac{1}{\sigma} \sim m_\chi^2$

$\frac{\rho^2 \sigma}{m_\chi^2} \sim \text{const}$

MEASURING A MASS WITH DIRECT DETECTION

- Can we set the scale for the next collider with a WIMP search?

DIRECT DETECTION UNCERTAINTIES

nuclear physics

$$\frac{dR}{dE_R} = N_T M_N \frac{\rho_\chi \sigma_n}{2 m_\chi \mu_{ne}^2} \frac{(f_p Z + f_n(A-Z))^2}{f_n^2} F^2[E_R] \int_{\beta_{min}}^{\infty} \frac{f(v)}{v} dv.$$

particle physics **astrophysics**

PP: Type of interaction, mediator

NP: Form factor - when de Broglie wavelength of interaction is comparable to nuclear size - resolve that it is not a point particle ($q^2 \sim 2 M_N E_R \Rightarrow E_R \sim 100$ keV) (Duda, Gondolo+Kemper 0608035)

AP: How many particles are there at a given velocity *in the Earth frame*

- The *only* relevance of WIMP mass in DD exps is the reduced mass

COULD WE MEASURE THE MASS

- Hard. Very, very hard.

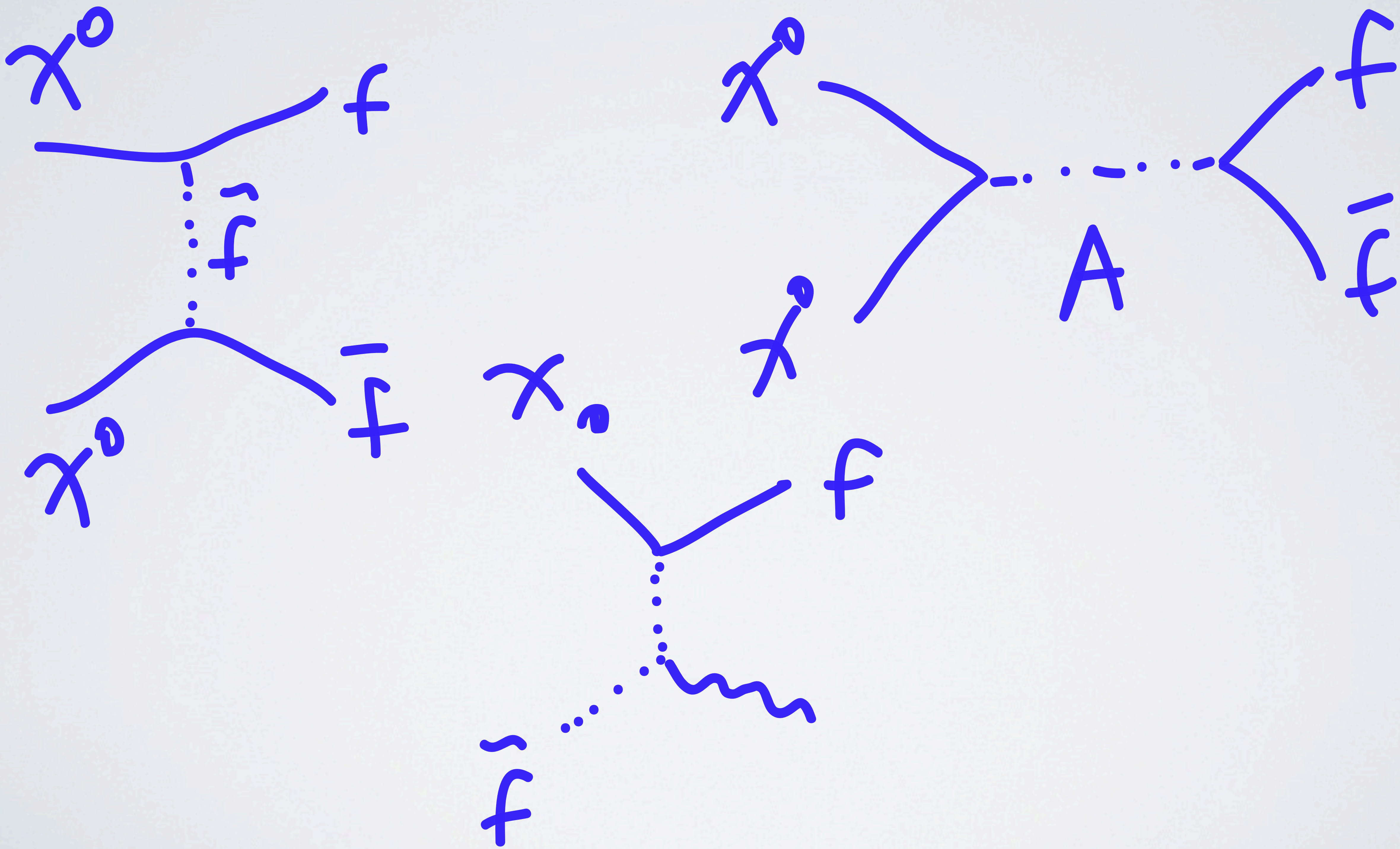
“STANDARD” SUSY

- The absence of spartners and the high Higgs mass may be telling us something:
- A “chaotic” SUSY model can easily have LSPs at low masses
- A “decoupled color” model can have electroweakinos at a light scale
- A “natural” unnatural SUSY model still have gauginos at the TeV scale, and be discoverable

BROADENING THE SCOPE

WHAT SUSY DOES FOR YOU

- A singlet, a doublet and a triplet with some specific couplings



WHAT SUSY DOES FOR YOU

- Baryon and lepton number violation operators

LLE UDD LH

QLD

- Hence, a parity *that we invoke by hand*

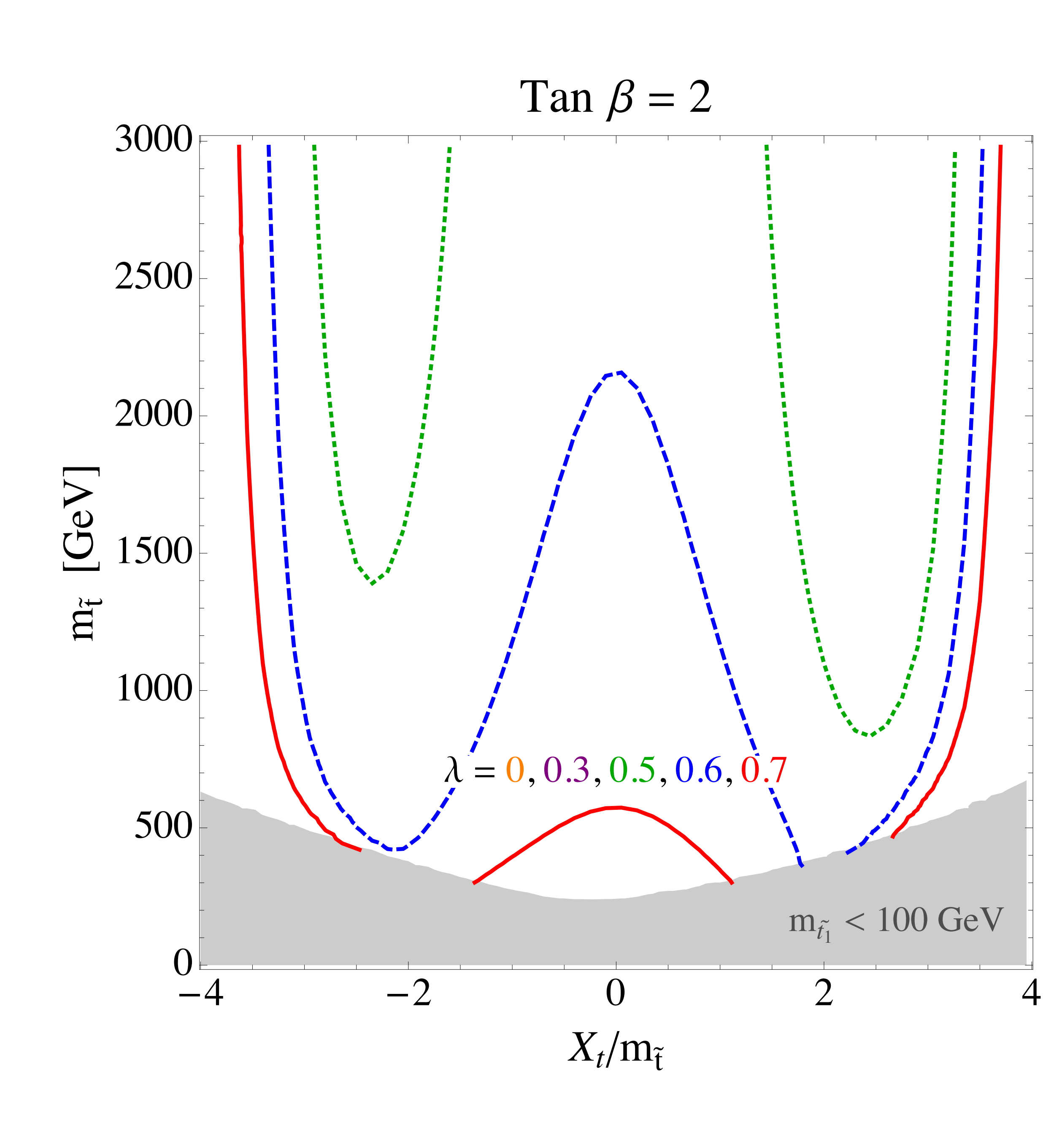
NEW STATES AT THE WEAK SCALE

In SUSY the Higgs is light for no good reason!

"X" may keep other things light, too

THE NMSSM AND DARK MATTER

Hall, Pinner, Ruderman '11



THE NMSSM

$$W = \lambda S H_u H_d$$

A complete standard model singlet?

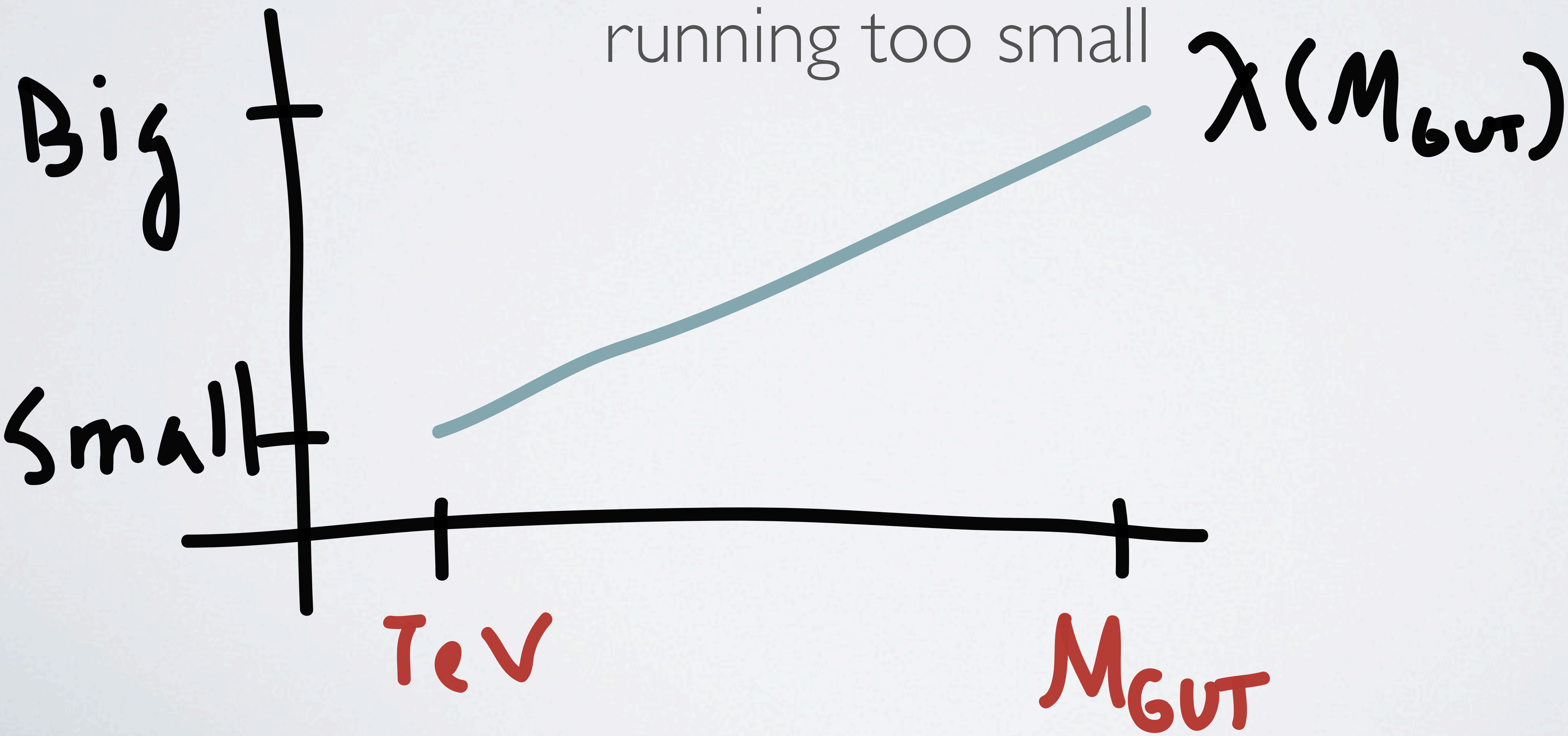
tadpoles? domain walls?

THE NMSSM

$$W = \lambda S H_u H_d$$

Yukawa couplings run weak at low energies

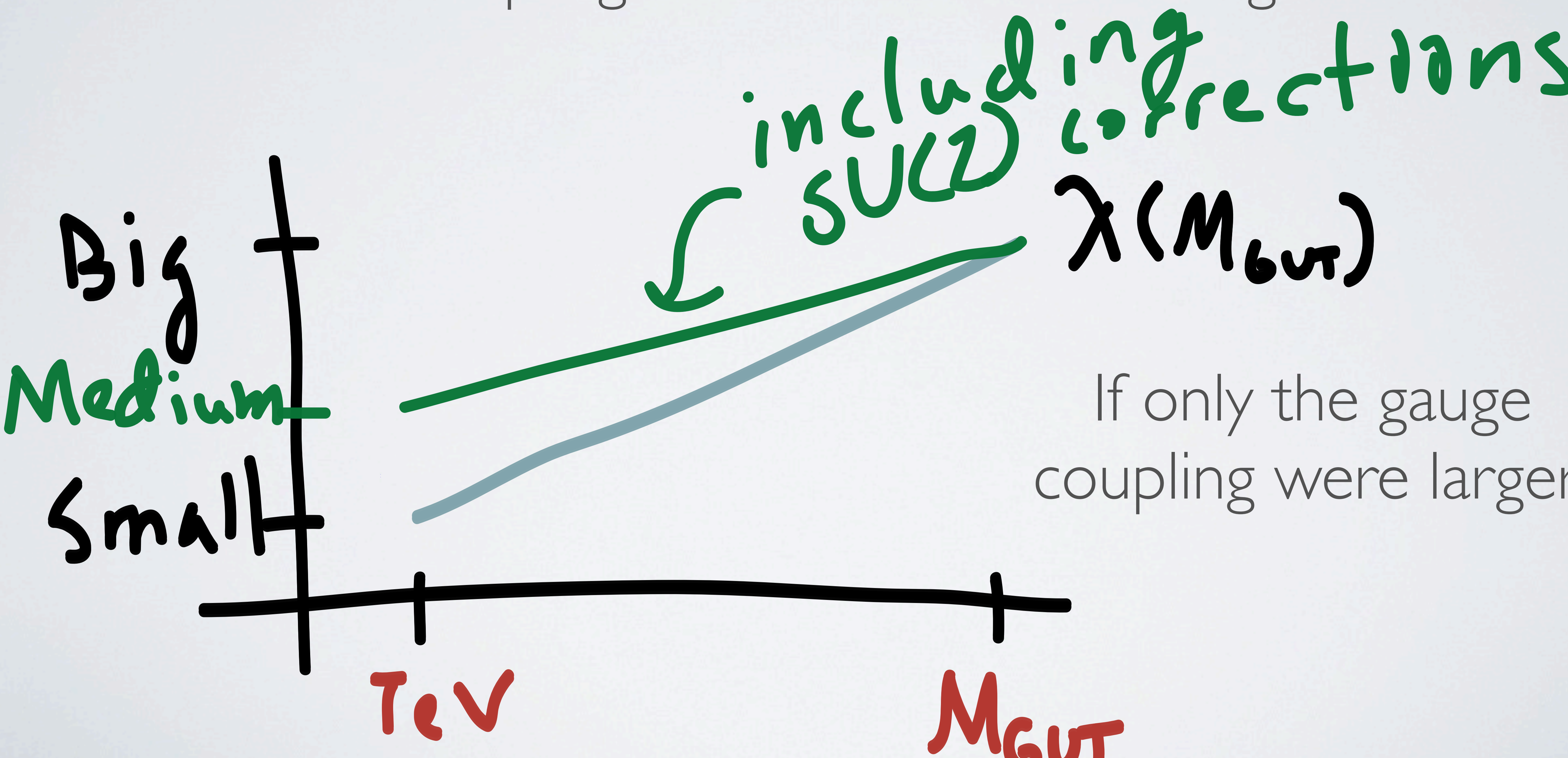
But gauge interactions keep it from running too small



THE NMSSM

$$W = \lambda S H_u H_d$$

Yukawa couplings run weak at low energies



If only the gauge coupling were larger!

REEXAMINING NMSSM

$$W = \lambda S H_u H_d$$

$$V \sim \lambda^2 |h_u h_d|^2$$

- quartic is $(h_u\ h_d)$^2
- must be at small tan beta
  => h_d has no large couplings
- why are we trying to identify that thing with h_d ?
  => because it's there
- Why not think of it as something totally different?

A SISTER HIGGS

- proposal: h_d is not h_d, it is something else
- ie S H_u Σ_d
- Σ_d has no direct couplings to any fermions,
- "sister Higgs": Higgs that participates in EWSB but without tree level renormalizeable couplings to SM fermions

$$S H_u H_d \Rightarrow \phi H_u \Sigma_d$$

	ϕ	$\bar{\phi}$	H_u	H_d	Σ_u	Σ_d
$U(1)_Y$	0	0	$1/2$	$-1/2$	$1/2$	$-1/2$
$SU(2)_W$	1	1	2	2	2	2
G_s	R	$\bar{R}$	1	1	$\bar{R}$	R

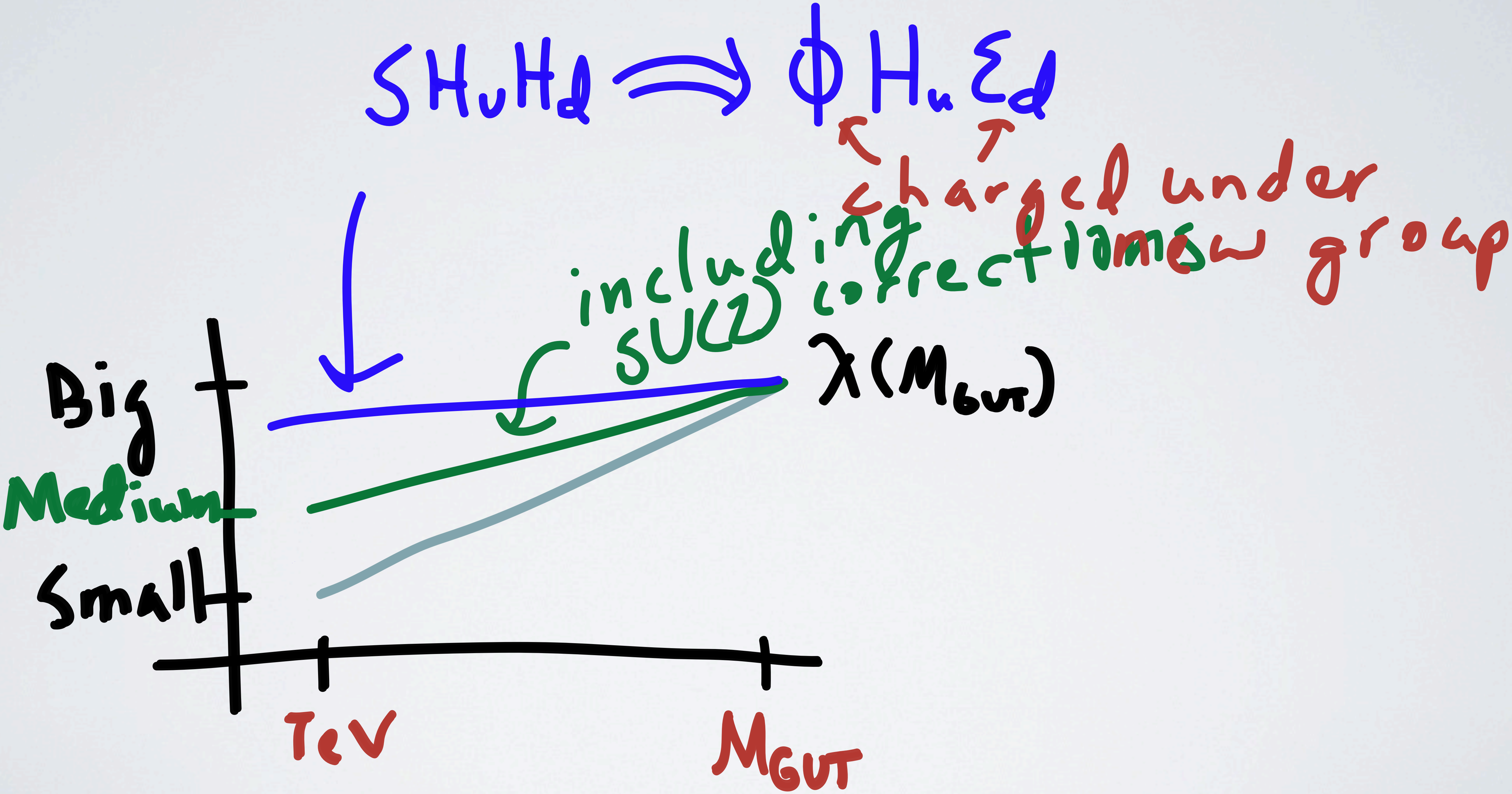
D. Alves, P. Fox, NW in progress

WHY A SISTER HIGGS

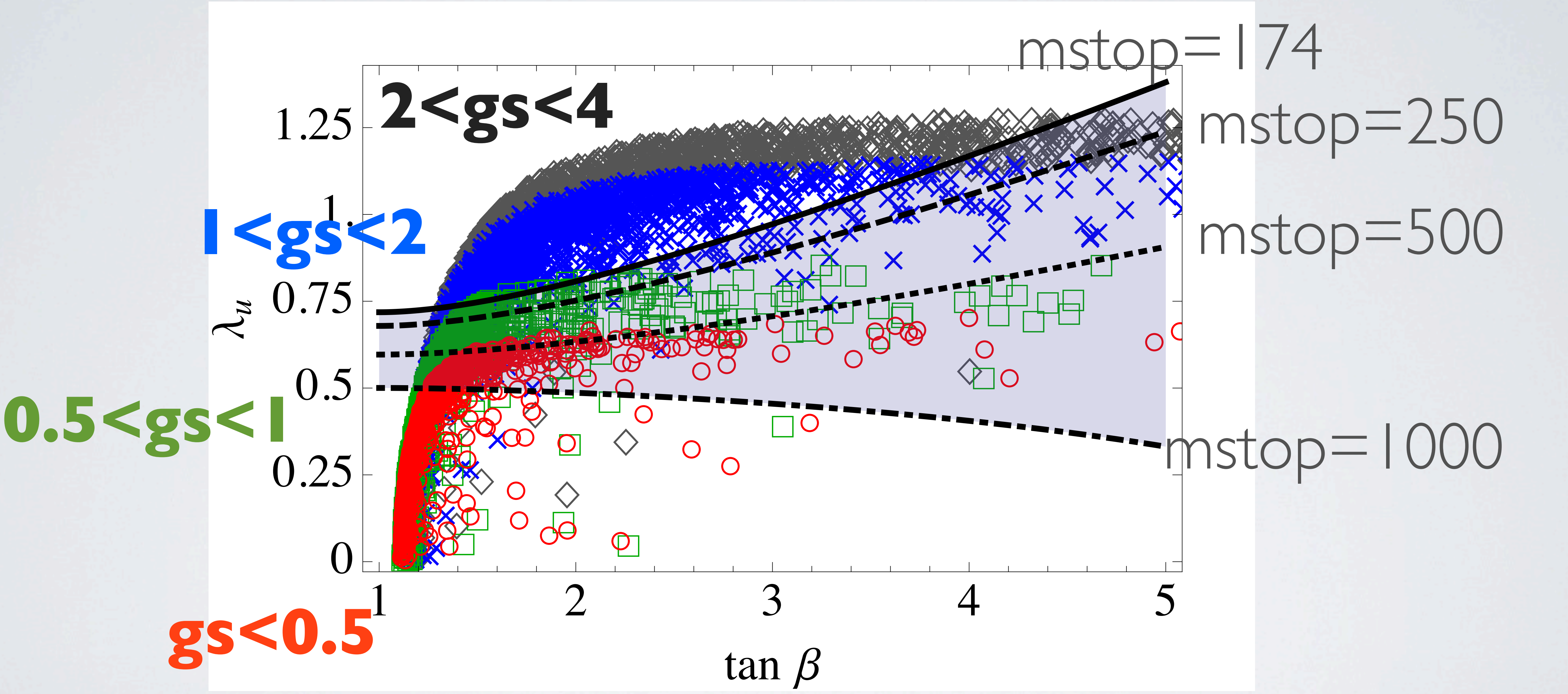
$$S H_u H_d \Rightarrow \Phi H_u \Sigma_d$$

can charge these

WHY A SISTER HIGGS



THE HIGGS MASS WITH A SISTER



DM WITH A SISTER

$\tilde{H}_u \quad \tilde{H}_d \quad \tilde{B} \quad \tilde{W}_3$

$\Sigma_u^0 \quad \Sigma_d^0 \quad \phi \quad \bar{\phi}$

$\tilde{Z}'$

SISTER HIGGS

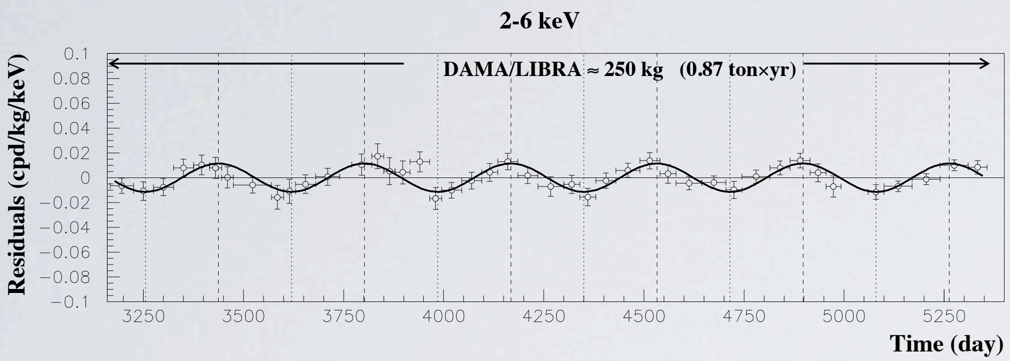
- Sister Gauge group may be broken to contain a residual U(1)
- Lightest Sister Particle is then stable
- => ‘ino like DM but not in cascades

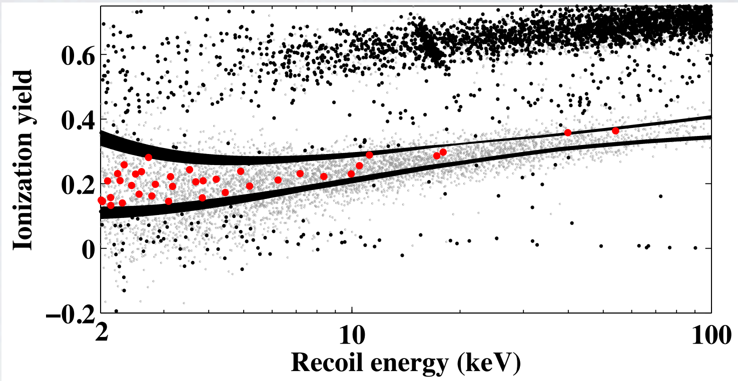
THE ERA OF DATA (1)

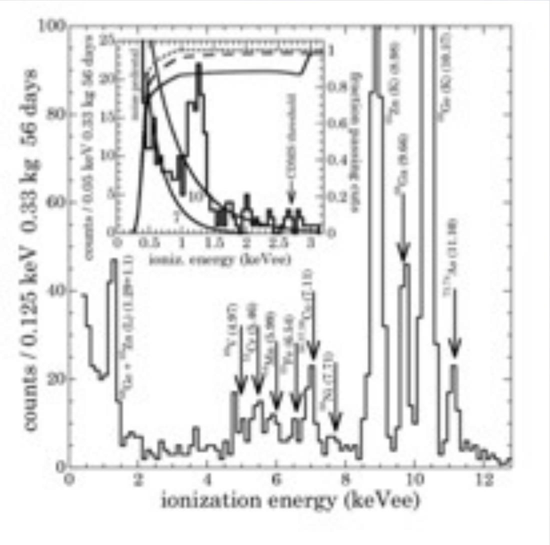
- The lack of MET signals may tell us
  - SUSY is heavy
  - SUSY is squeezed
  - SUSY is hidden (e.g., RPV)
  - None of these things tell us that there is no SUSY DM
- The lack of a (conventional) DD signal has begun constraining Higgs portal models

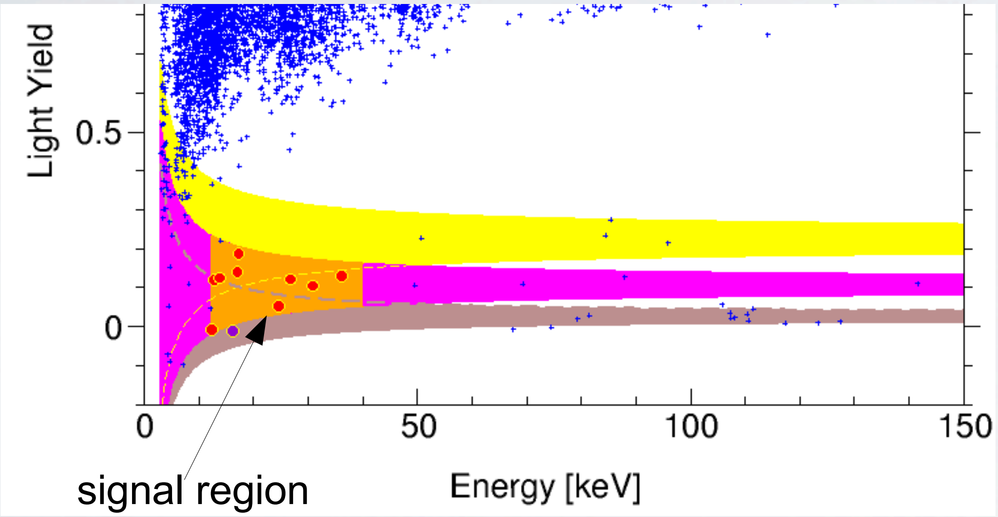
THE REAL SIGNIFICANCE OF THE ERA OF DATA

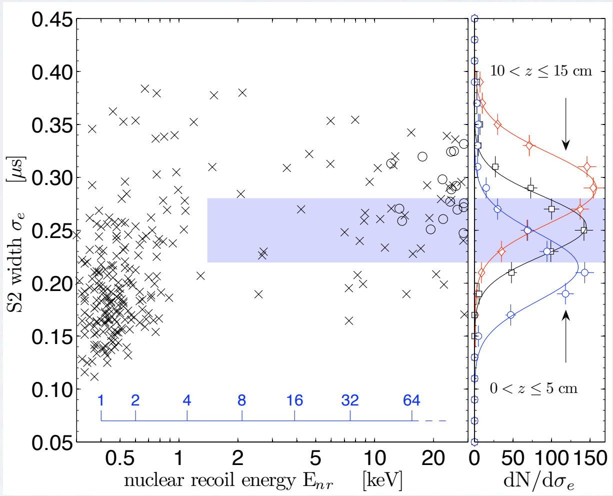
ANOMALIES AND ANOMALIES

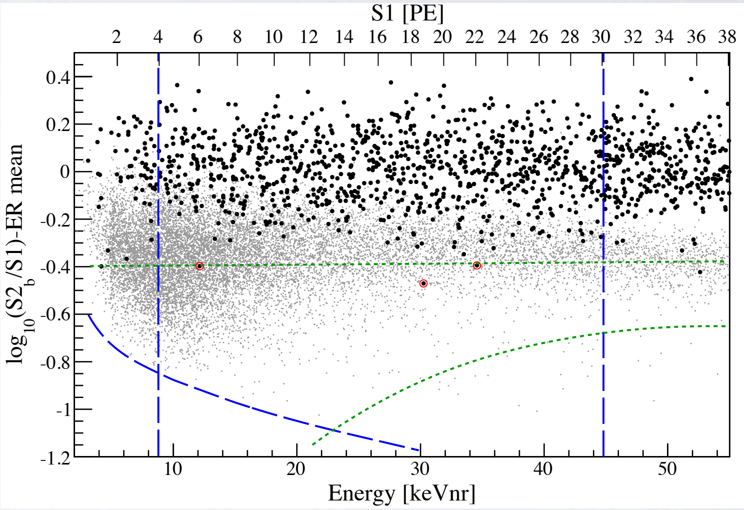


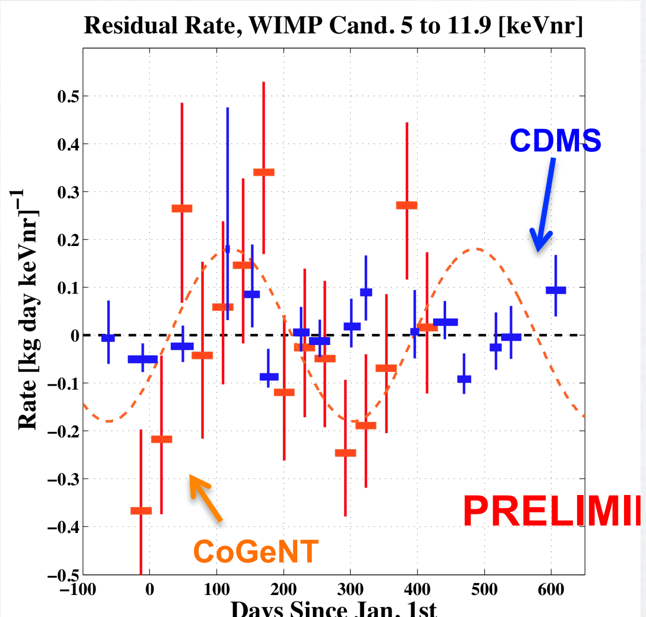


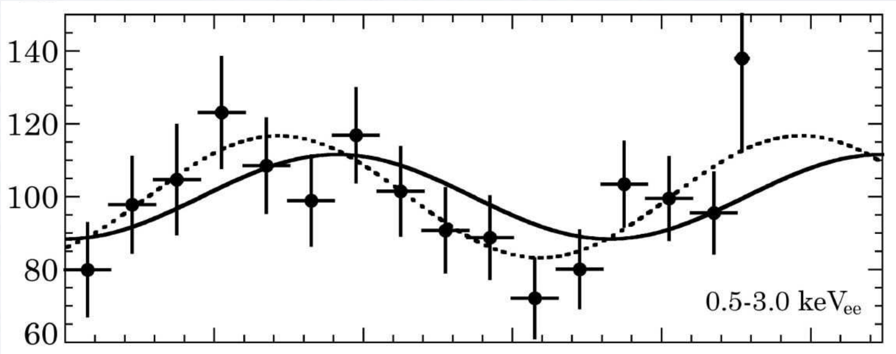




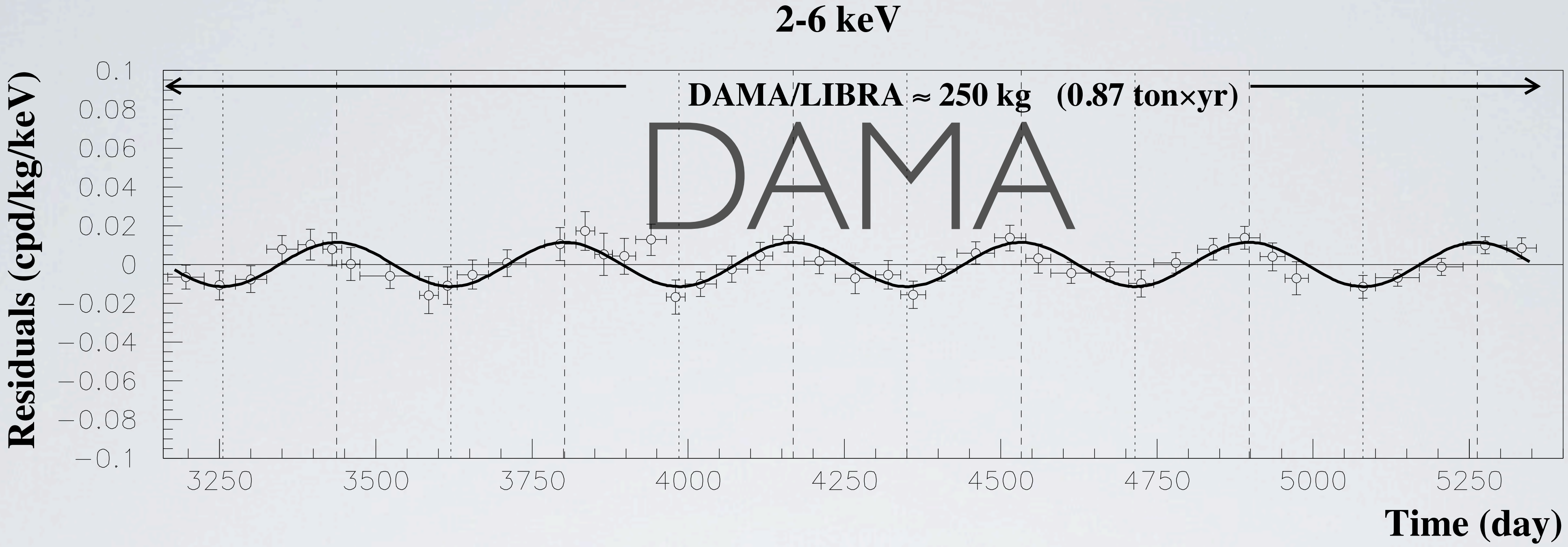




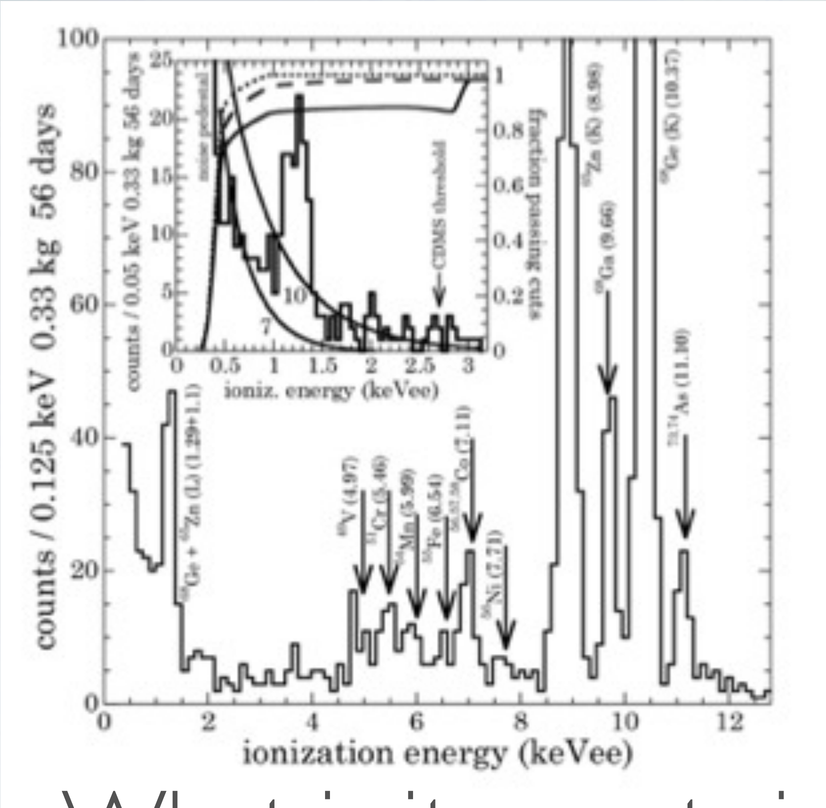




DAMA

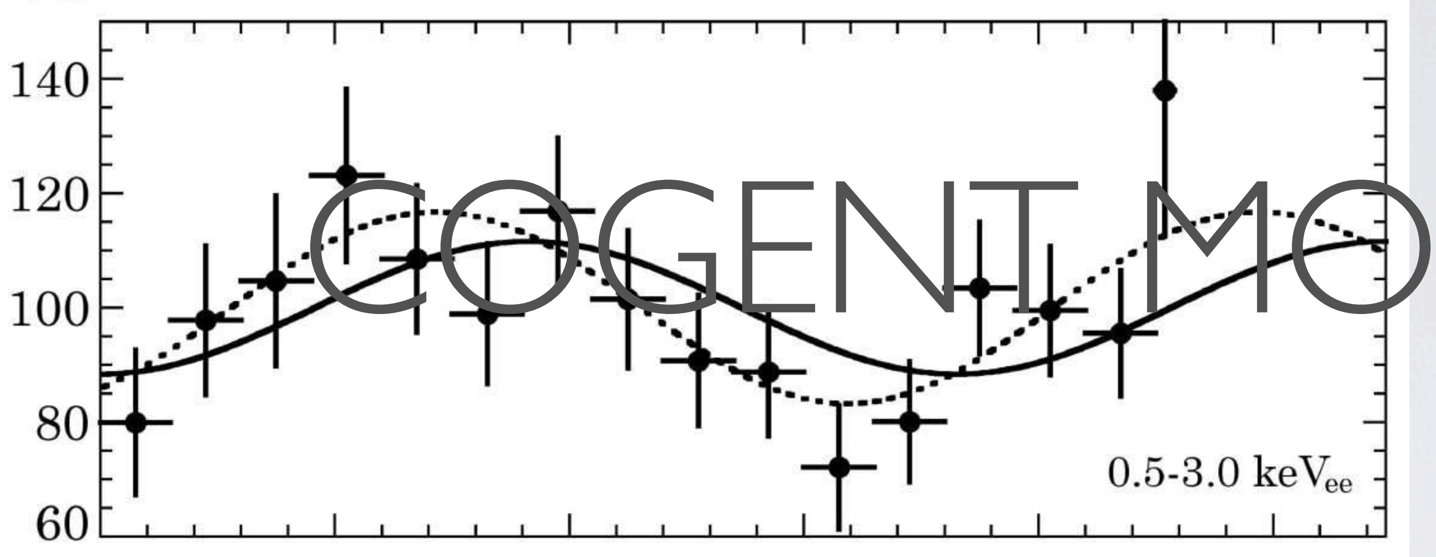


- What is it: annual modulation in scintillation events in 100/250 kg NaI(Tl) crystal - DM?
- What's to like: single hit, stable phase, low energy, no candidate "conventional" explanations
- What's not to like: null results from other exps, data are still unavailable, no event discrimination



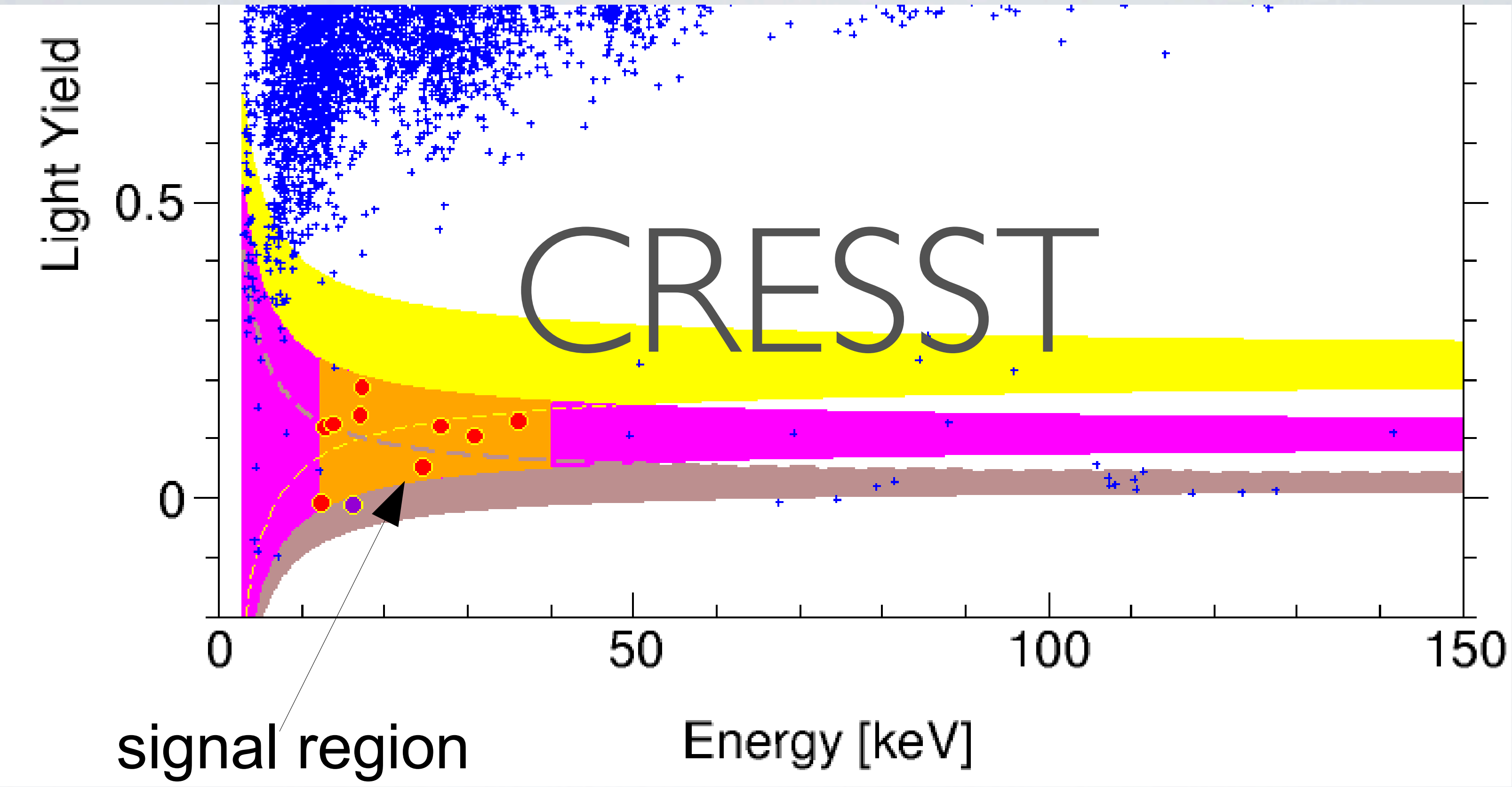
COGENT

- What is it: events in an ionization experiment, x10 larger than expected background - DM?
- What's to like: excellent energy resolution/calibration, good statistics
- What's not to like: no discrimination, hasn't been mercilessly beaten for a decade, sizeable surface event contamination, null results from other exps



COGENT MODULATION

- What is it: an annual modulation in the "low energy" portion of the experiment
- What's to like: sizeable statistical presence
- What's not to like: statistically present in upper half as well as lower half; null results



- What is it: an excess of events in a $CaWO_4$ detector, consistent with Oxygen scattering (~10-40 keV)

- What's to like: good discrimination vs electron recoil, not muon induced neutrons

- What's not to like: lots of events at high (15 keV+ energy, should have been seen elsewhere), signal lies left, right, above and below clear background sources, still have only seen 2 of 9 detectors, naively low energy looks too clean to be WIMP

THE CONTROVERSY

3) **Comments on arXiv:1006.0972 'XENON10/100 dark matter constraints in comparison with CoGeNT and DAMA: examining th**
J.I. Collar, . Jun 2010. 2pp. Temporary entry
e-Print: **arXiv:1006.2031** [astro-ph.CO]

References | LaTeX(US) | LaTeX(EU) | Harvmac | BibTeX | Keywords | Cited 10 times
Abstract and Postscript and PDF from arXiv.org (mirrors: au br cn de es fr il in it jp kr ru tw uk za aps lanl)
Bookmarkable link to this information

4) **Response to arXiv:1005.2615.**
J.I. Collar, D.N. McKinsey, . May 2010. Temporary entry
e-Print: **arXiv:1005.3723** [astro-ph.CO]

References | LaTeX(US) | LaTeX(EU) | Harvmac | BibTeX | Cited 15 times
Abstract and Postscript and PDF from arXiv.org (mirrors: au br cn de es fr il in it jp kr ru tw uk za aps lanl)
Bookmarkable link to this information

5) **Reply to the Comments on the XENON100 First Dark Matter Results.**
The XENON100 Collaboration, . May 2010. Temporary entry
e-Print: **arXiv:1005.2615** [astro-ph.CO]

References | LaTeX(US) | LaTeX(EU) | Harvmac | BibTeX | Keywords | Cited 14 times
Abstract and Postscript and PDF from arXiv.org (mirrors: au br cn de es fr il in it jp kr ru tw uk za aps lanl)
Bookmarkable link to this information

6) **Comments on 'First Dark Matter Results from the XENON100 Experiment'.**
J.I. Collar, D.N. McKinsey, . May 2010. Temporary entry
e-Print: **arXiv:1005.0838** [astro-ph.CO]

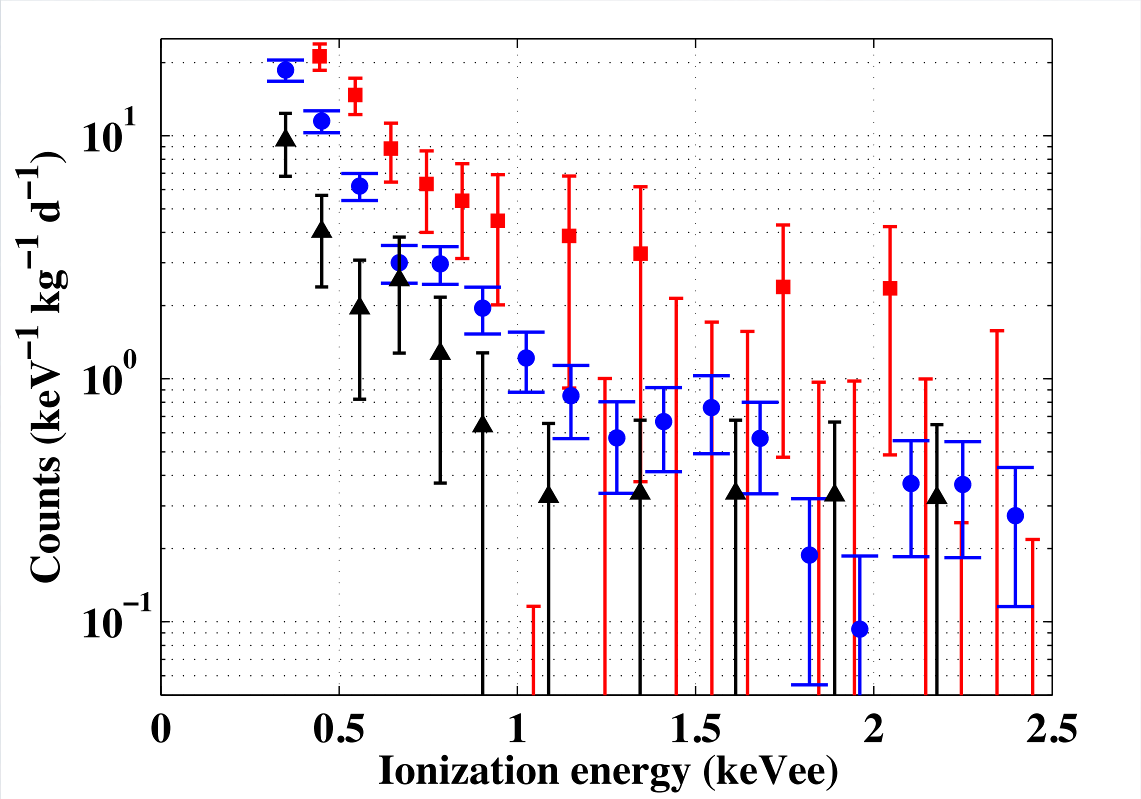
References | LaTeX(US) | LaTeX(EU) | Harvmac | BibTeX | Keywords | Cited 22 times
Abstract and Postscript and PDF from arXiv.org (mirrors: au br cn de es fr il in it jp kr ru tw uk za aps lanl)
Bookmarkable link to this information

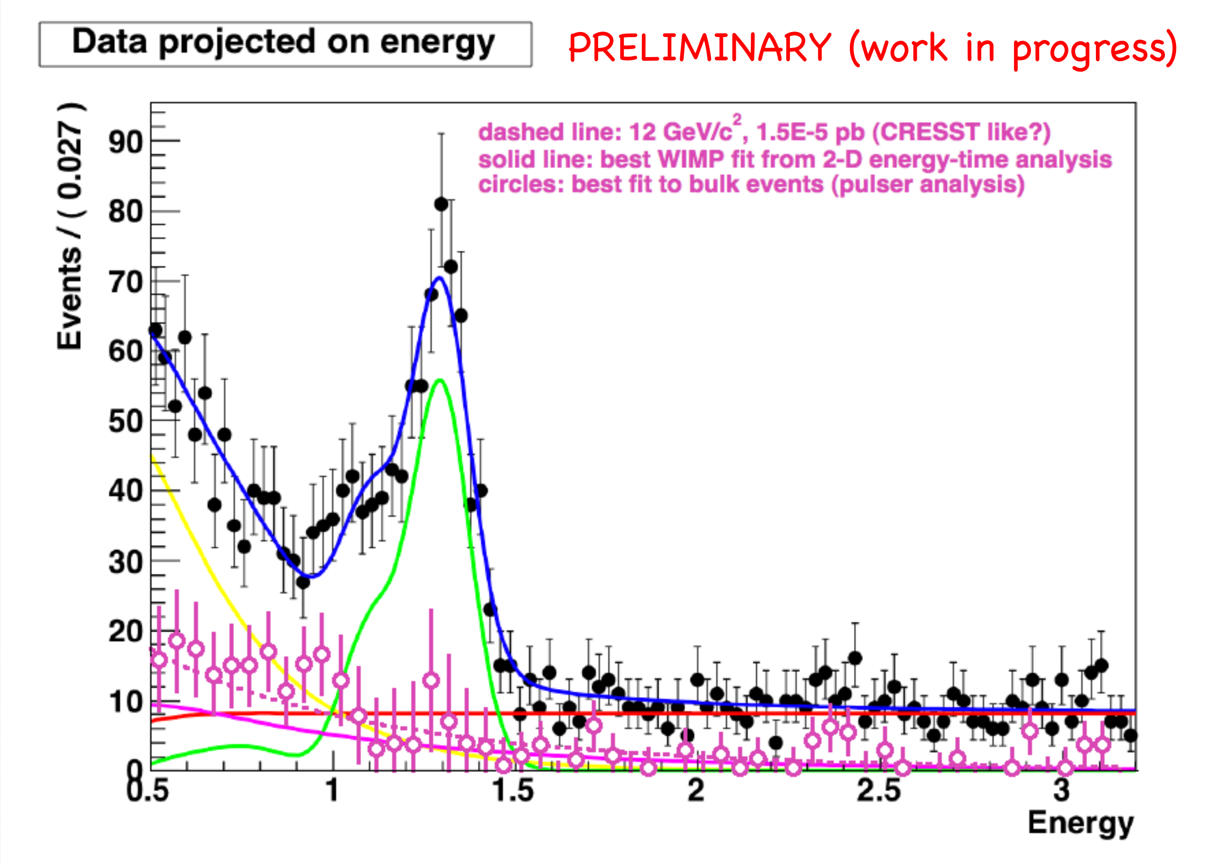
7) **First Dark Matter Results from the XENON100 Experiment.**
By XENON100 Collaboration (E. Aprile *et al.*). May 2010. (Published Sep 24, 2010). 4pp.
Published in **Phys.Rev.Lett.105:131302,2010**.
e-Print: **arXiv:1005.0380** [astro-ph.CO]

TOPCITE = 50+
References | LaTeX(US) | LaTeX(EU) | Harvmac | BibTeX | Keywords | Cited 103 times
Abstract and Postscript and PDF from arXiv.org (mirrors: au br cn de es fr il in it jp kr ru tw uk za aps lanl)
Journal Server [doi:10.1103/PhysRevLett.105.131302]
EXP XENON
Bookmarkable link to this information

FIND KEYWORD BIG TIZZY

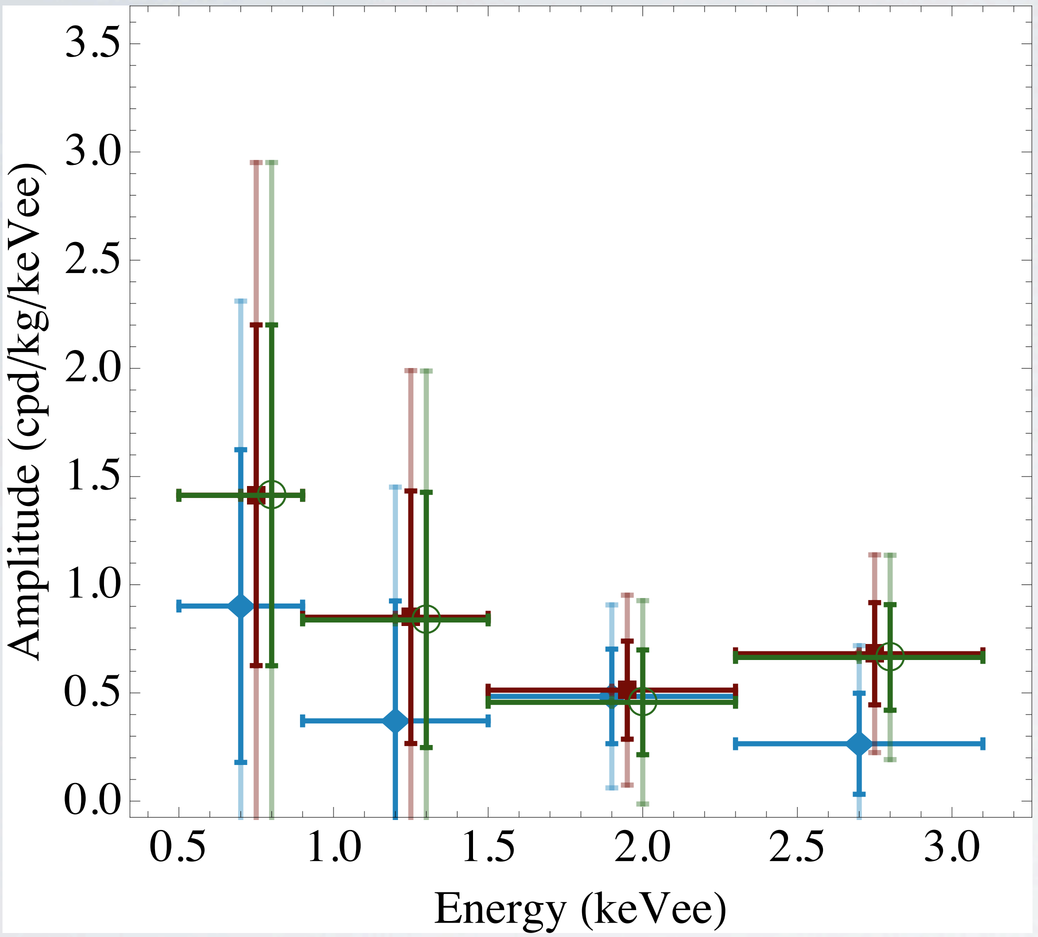
COGENT->CDMS

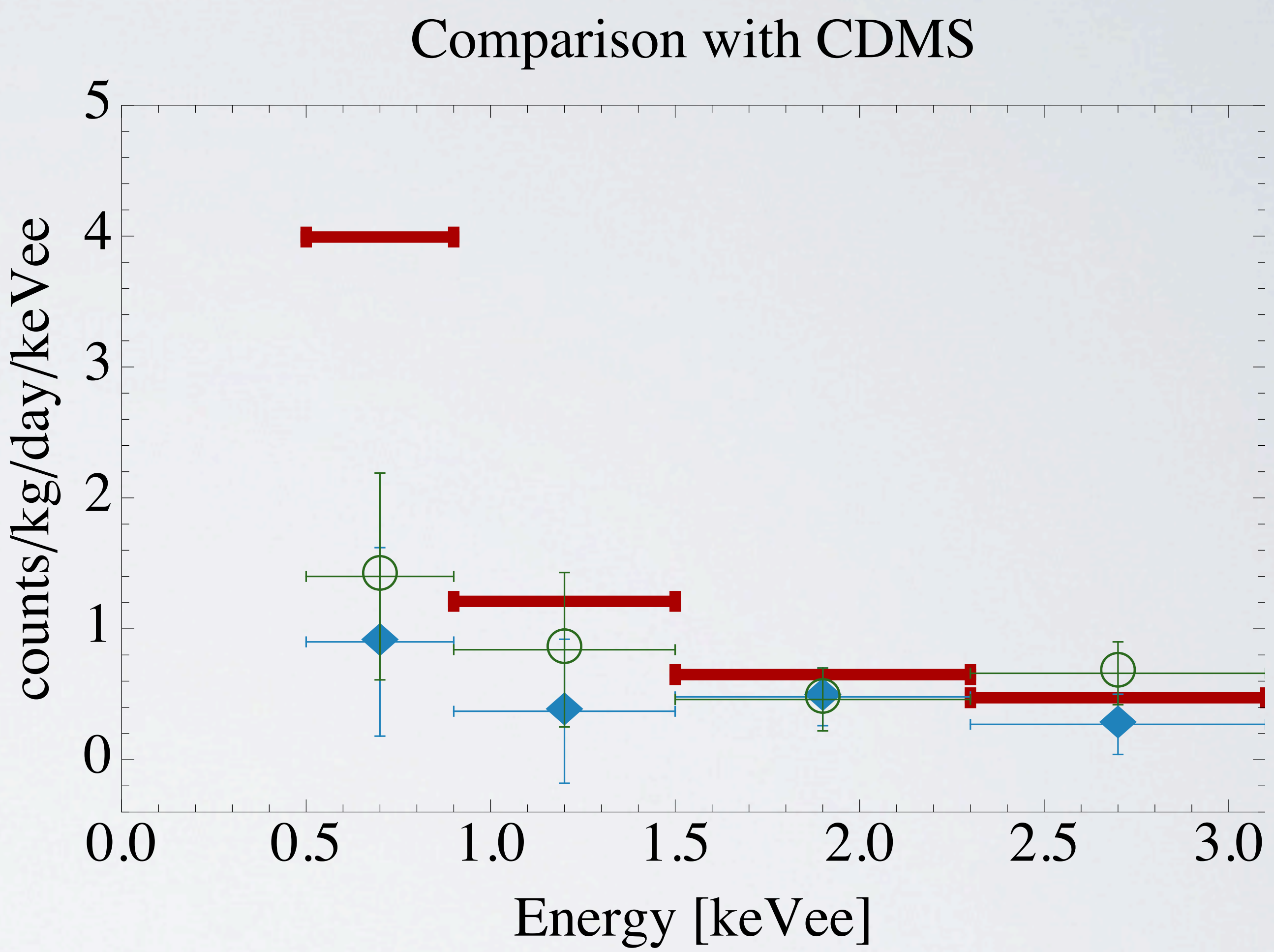




With surface event subtraction no a priori conflict

COGENT MODULATION

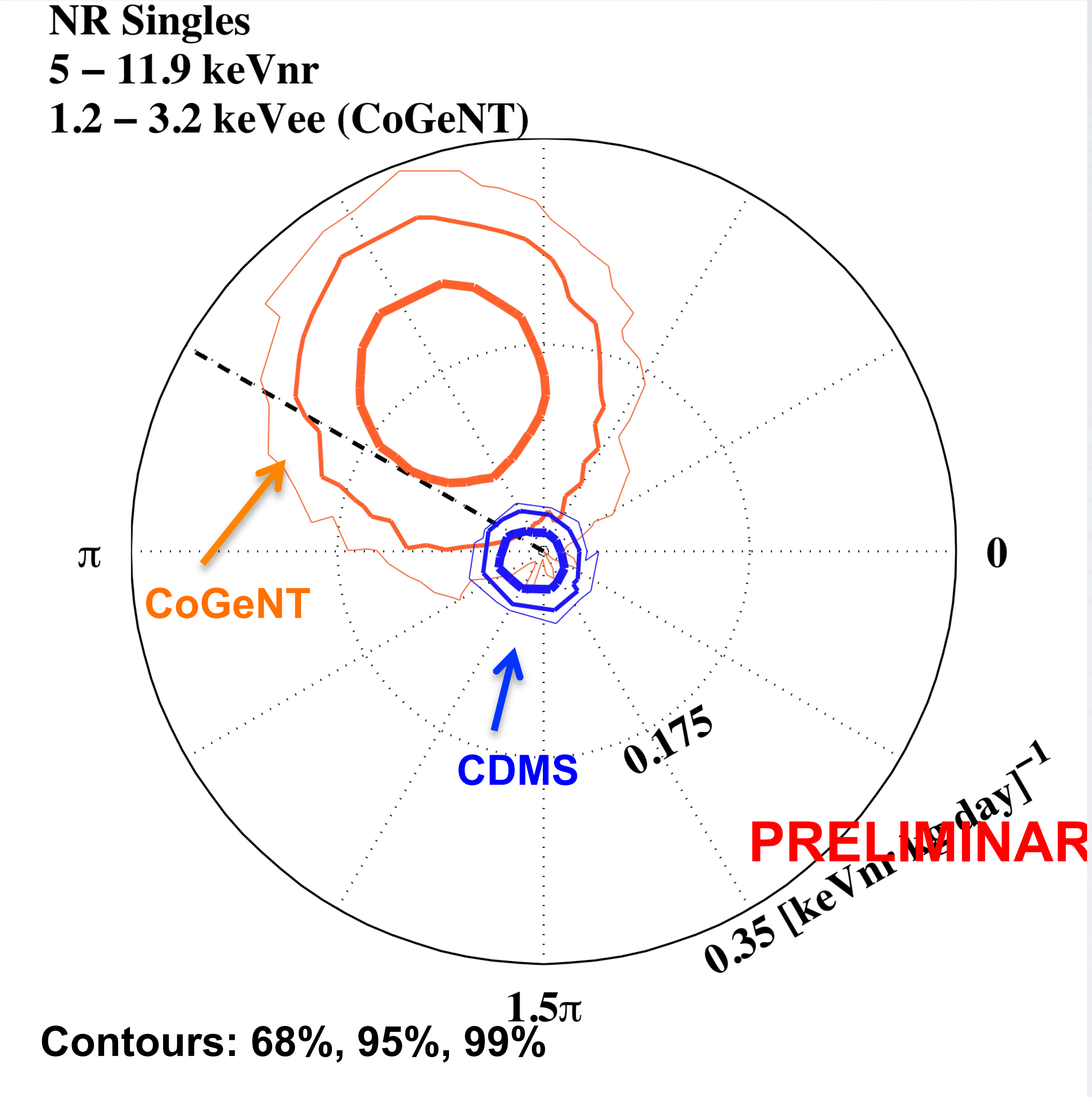




CDMS should see O(1) modulation in the 1+ keVee range

Fox, Kopp, Lisanti, NW 1107.0717

COGENT MODULATION



WHERE ARE WE W/ COGENT

- Limits from CDMS, XENON (ionization+scintillation, ionization only) seem strong
- New measurements of surface contamination shift region downward - but make presence of bulk events uncertain
- Modulation seems highly constrained by CDMS

BUT WHAT ABOUT THE REST?

- Is there really a conflict?

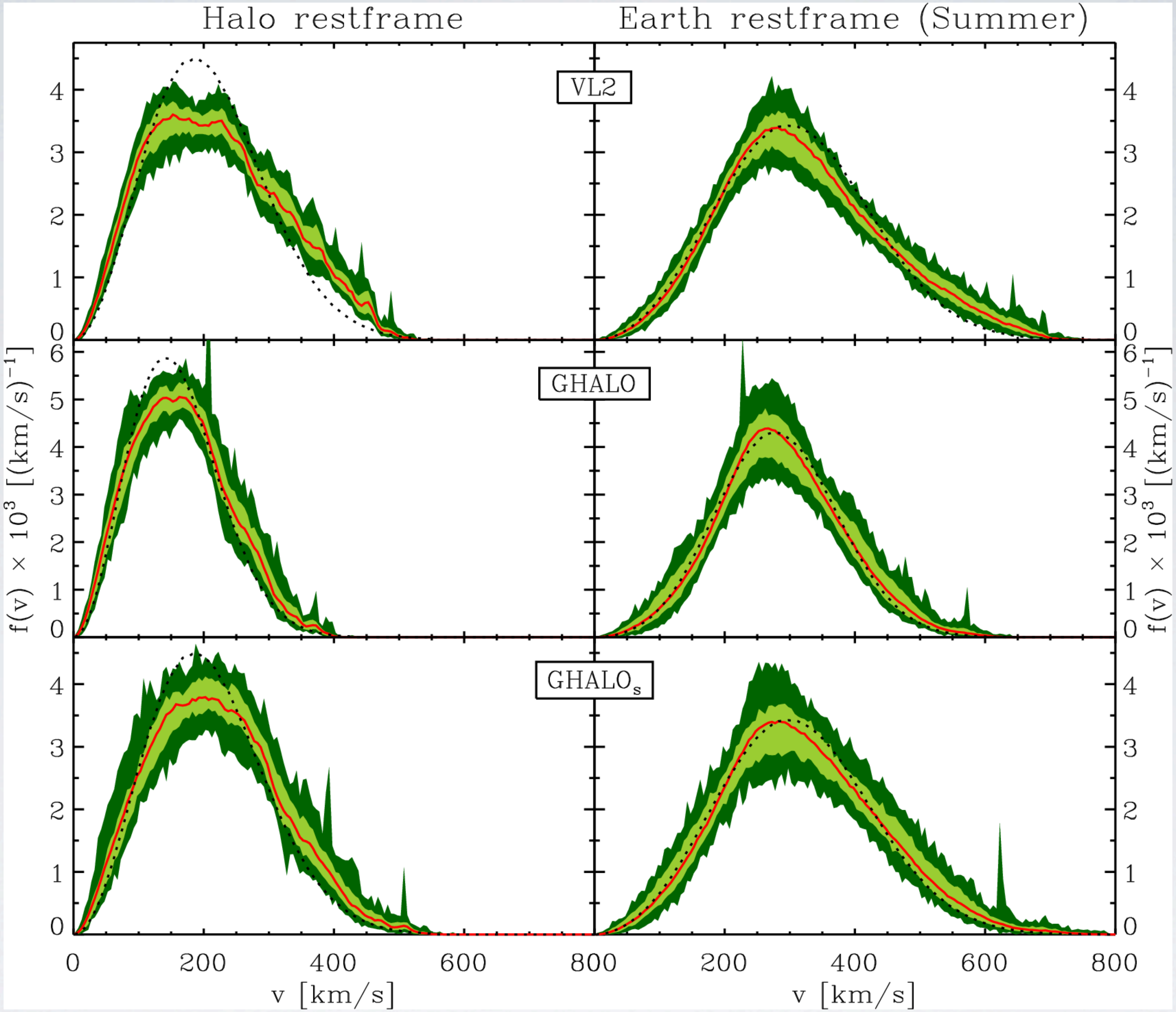
DATA CONFRONT DATA

the usual approach

PROBLEM

- Many scenarios (light WIMPs, inelastic WIMPs etc) sample high velocity tail of the WIMP distribution

Kuhlen, et al



MB generally good near the peak, generally not near the tail

TWO KEY POINTS

$$\frac{dR}{dE_R} = \frac{N_T M_T \rho}{2 m_\chi \mu^2} \sigma(E_R)\, g(v_{min})$$

1) all the energy dependence is in two functions

$$g(v_{min}) = \int_{v_{min}}^{\infty} d^3v \, \frac{f(\mathbf{v}, t)}{v}$$

$$\sigma_{SI}(E_R) = \sigma_p \frac{\mu^2}{\mu_{n\chi}^2} \frac{(f_p Z + f_n (A - Z))^2}{f_p^2} F^2(E_R)$$

$$v_{min} = \sqrt{\frac{M_T E_R}{2\mu^2}}$$

2) there is a 1-1 mapping between velocity and energy

THE IDEA: PART 1

- Suppose you want to compare two experiments, 1 and 2

$$[E^1_{low}, E^1_{high}] \Rightarrow [v^{1,low}_{min}, v^{1,high}_{min}]$$

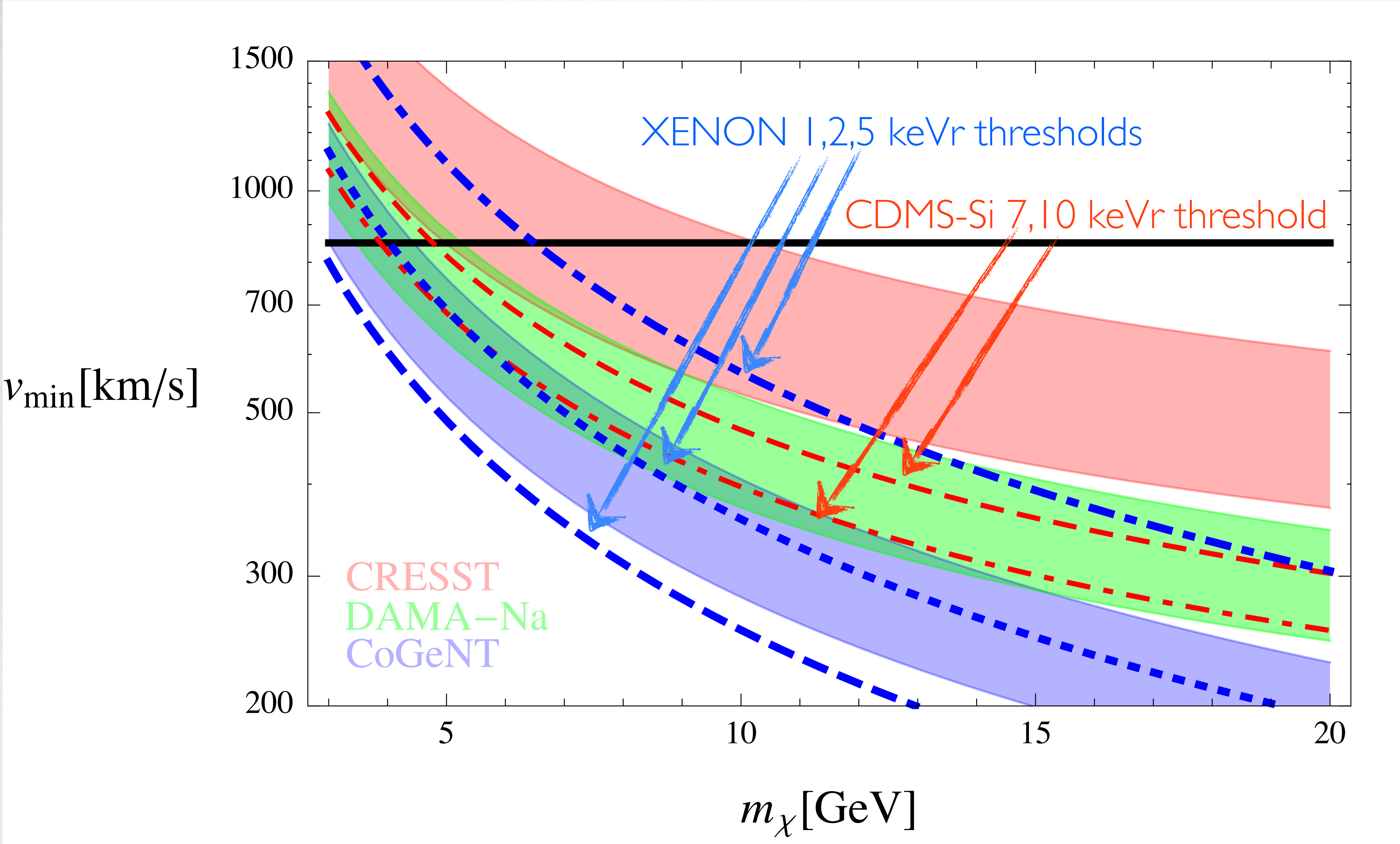
map the energy range studied in experiment 1 to a velocity space range

map velocity space range back to energy space for experiment 2

$$[v^{1,low}_{min}, v^{1,high}_{min}] \Rightarrow [E^2_{low}, E^2_{high}]$$

we now have an energy range where the experiments are studying the *same* particles

$$[E^1_{low}, E^1_{high}] \Leftrightarrow [E^2_{low}, E^2_{high}]$$



Approx. range	O	Na	Si	Ar	Ge	Xe
CoGeNT (Ge): 2 - 4	4.3 - 8.6	3.9 - 7.8	3.6 - 7.2	3.0 - 6.0	2 - 4	1.3 - 2.5
DAMA (Na): 6 - 13	6.6 - 14	6 - 13	5.5 - 12	4.6 - 10	3.1 - 6.7	1.9 - 4.2
CRESST (O): 15 - 40	15 - 40	14 - 36	12 - 33	10 - 28	6.9 - 19	4.3 - 12

TABLE I: Conversion of energy ranges (all in keV) between various experiments/targets for a 10 GeV DM particle, using the expression in (7).

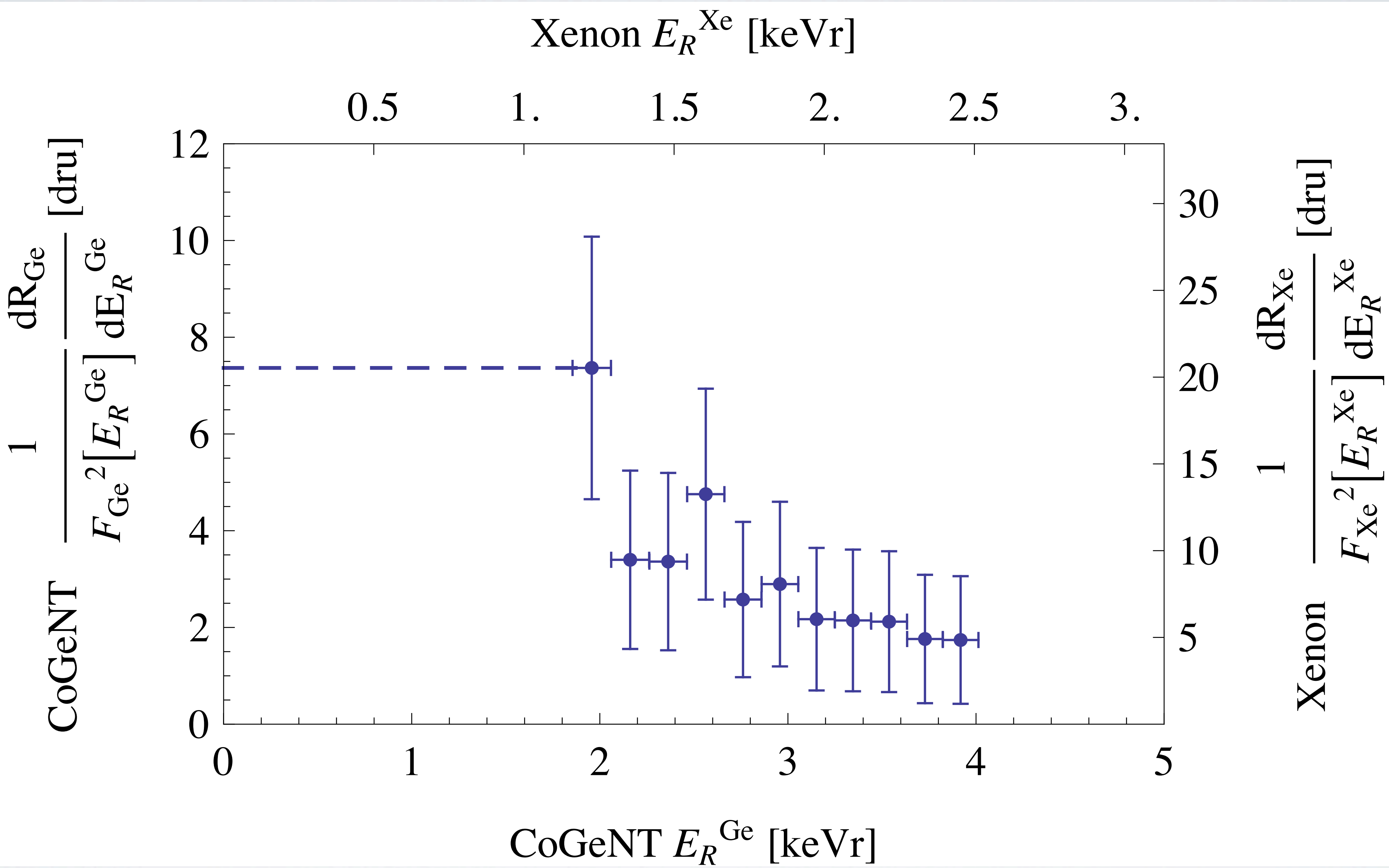
THE IDEA: PART 2

Invert:

$$\frac{dR}{dE_R} = \frac{N_T M_T \rho}{2m_\chi \mu^2}\sigma(E_R)\, g(v_{min}) \longrightarrow g(v) = \frac{2m_\chi \mu^2}{N_T M_T \rho \sigma(E_R)} \frac{dR_1}{dE_1}$$

$$\frac{dR_2}{dE_R}(E_2) = \frac{C_T^{(2)}}{C_T^{(1)}} \frac{F_2^2(E_2)}{F_1^2\left(\frac{\mu_1^2 M_T^{(2)}}{\mu_2^2 M_T^{(1)}} E_2\right)} \frac{dR_1}{dE_R}\left(\frac{\mu_1^2\, M_T^{(2)}}{\mu_2^2\, M_T^{(1)}} E_2\right)$$

A direct prediction of the rate
at experiment 2 from experiment 1



When new data finalize, can reapply, but approach is same

LIMITING G(V)

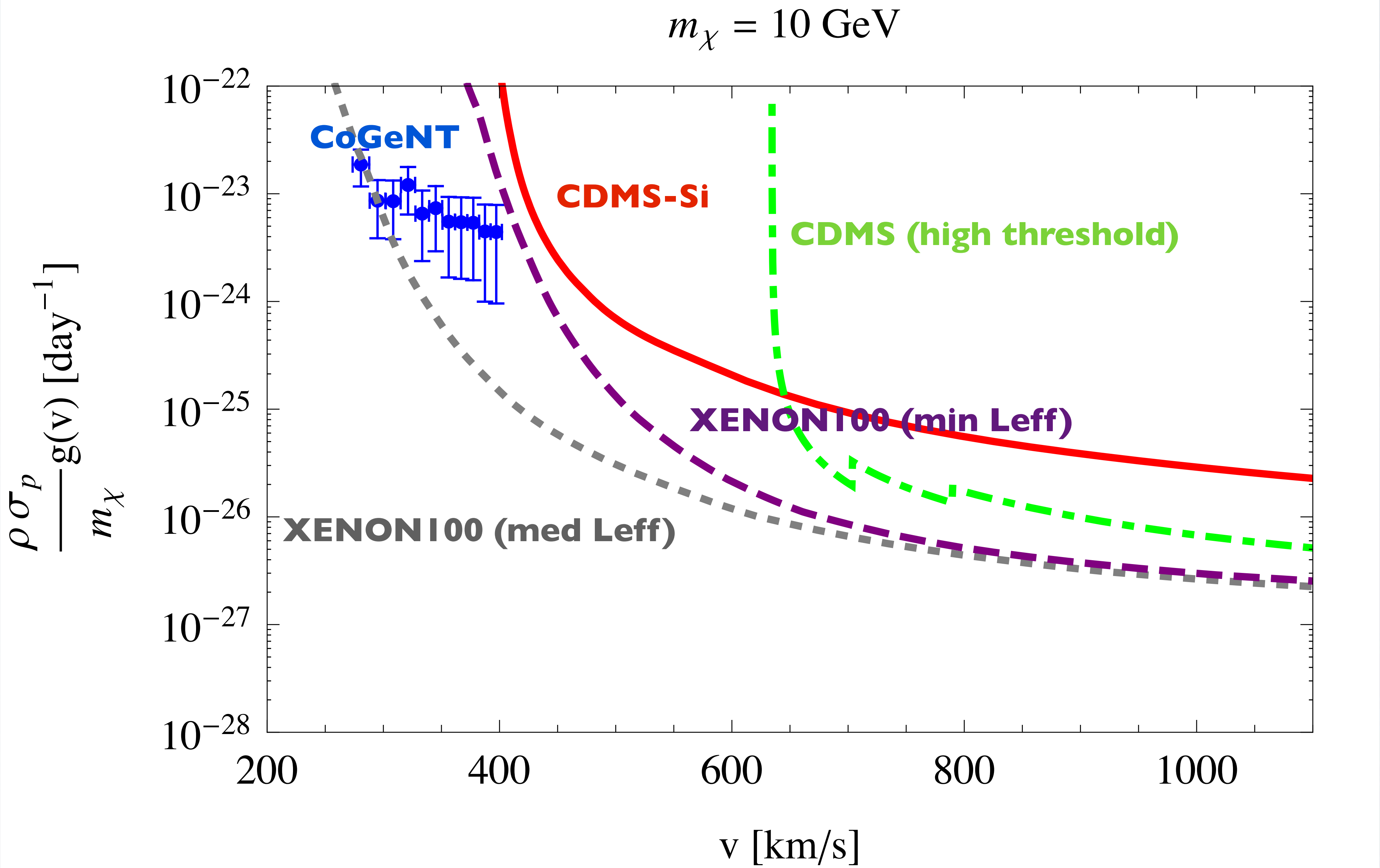
Most conservative assumption is theta function

$$g(v; v_1) = g_1 \Theta(v_1 - v)$$

i.e., do not assume velocity extends to known but exponentially suppressed values at high velocity

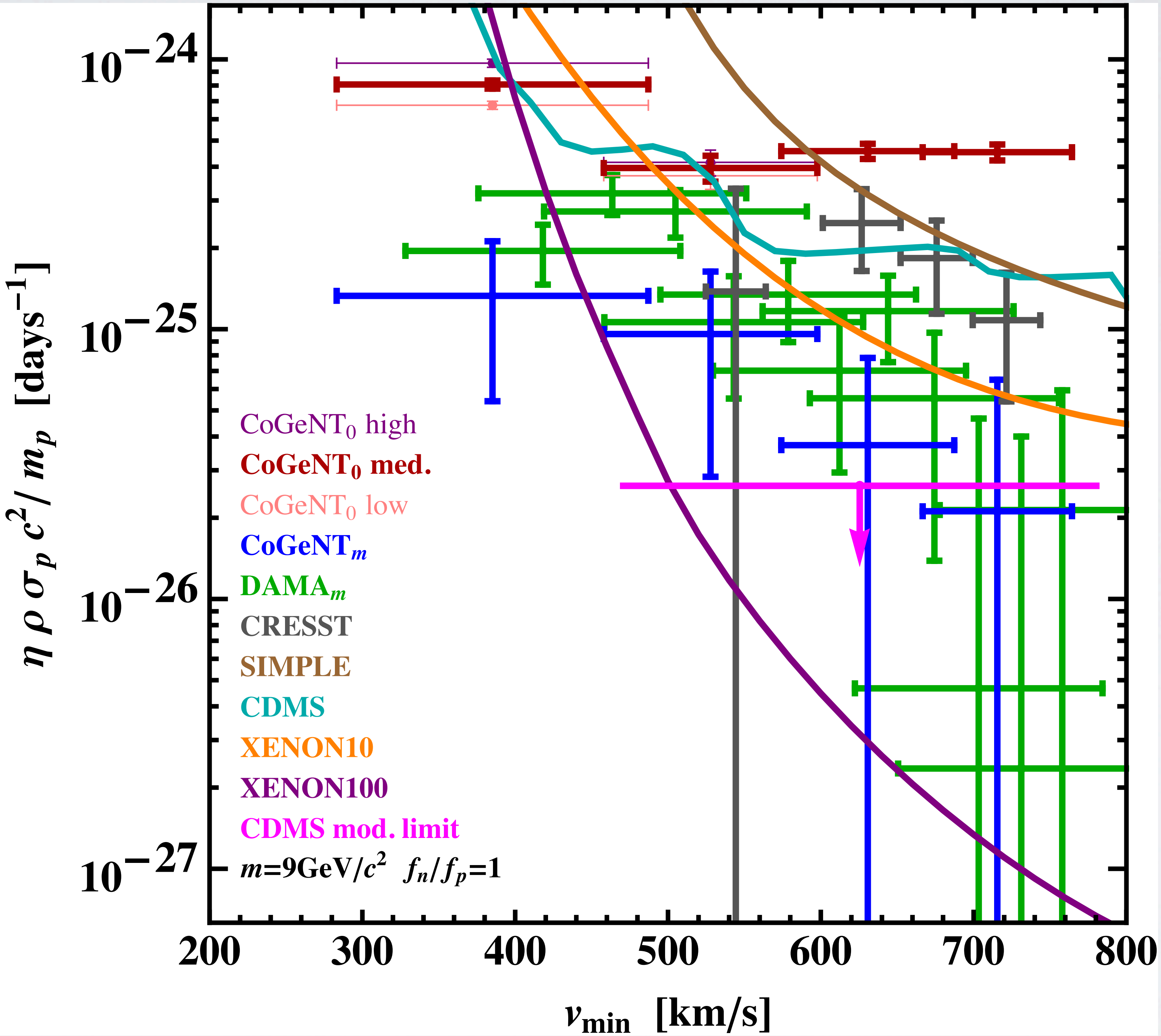
$$\frac{dR}{dE_R} = \frac{N_T M_T \rho}{2 m_\chi \mu^2} \sigma(E_R)\, g_1 \Theta(v_1 - v_{min}(E_R))$$

CONSTRAINING G(V)

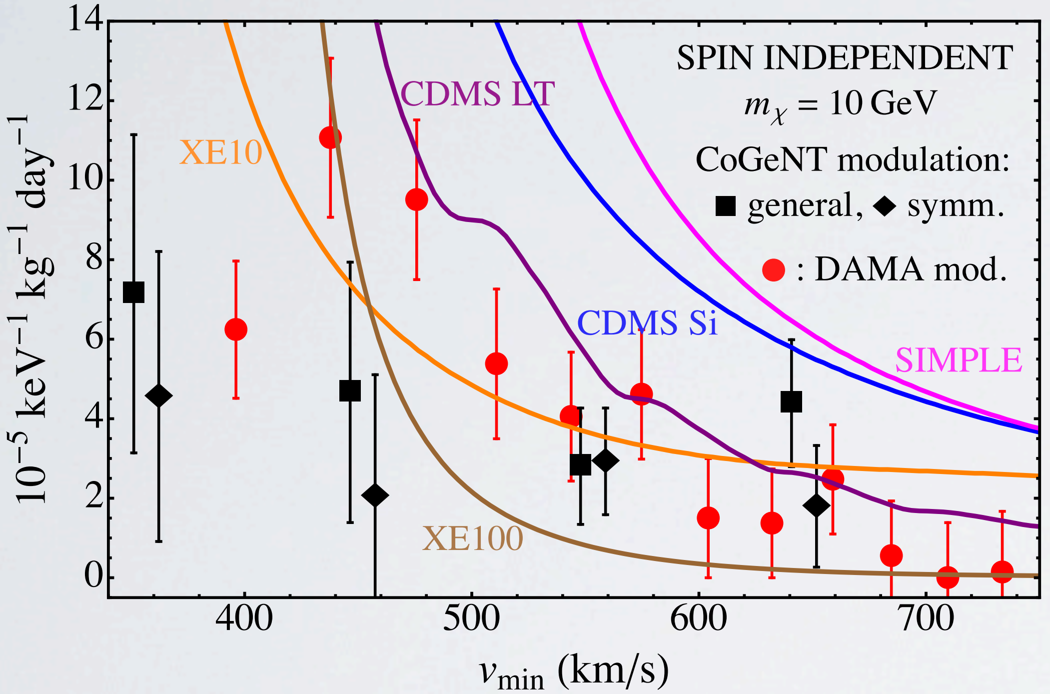


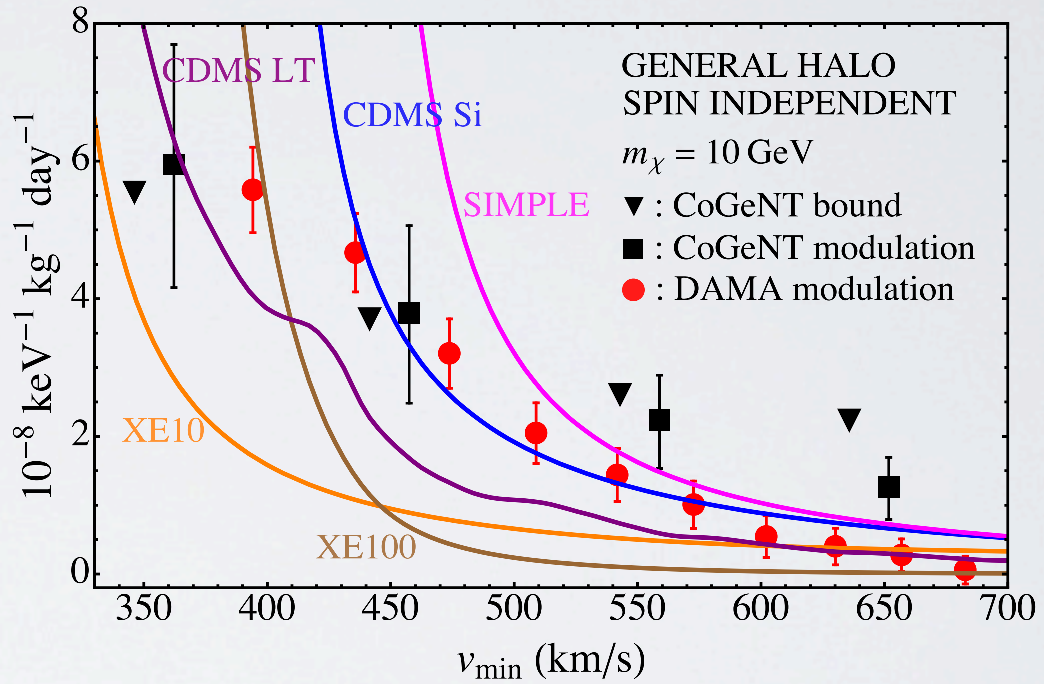
Fox, Liu, NW 1011.1915

CONSTRAINING G(V)



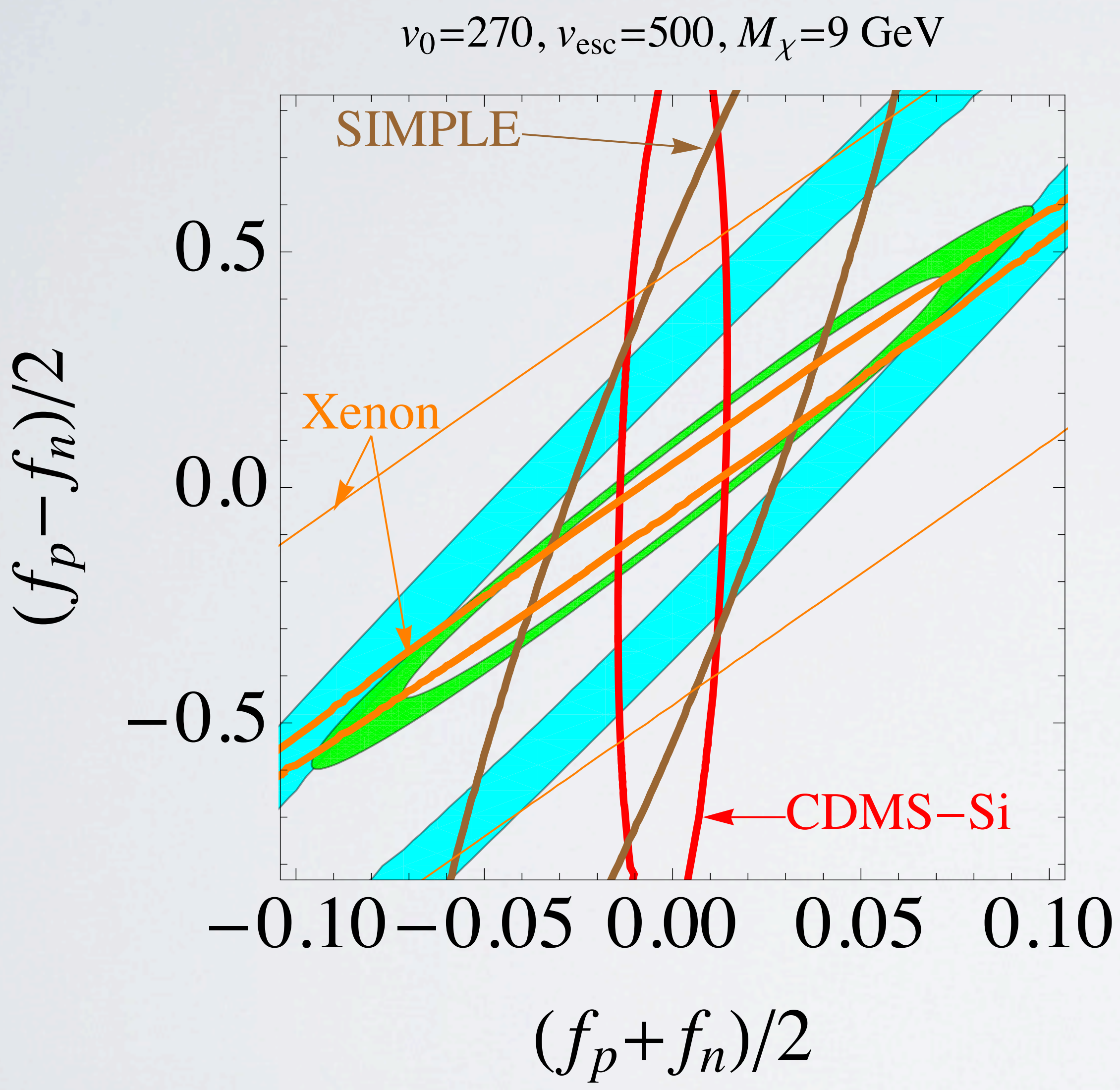
Gondolo, Gelmini '12; Frandsen et al '12



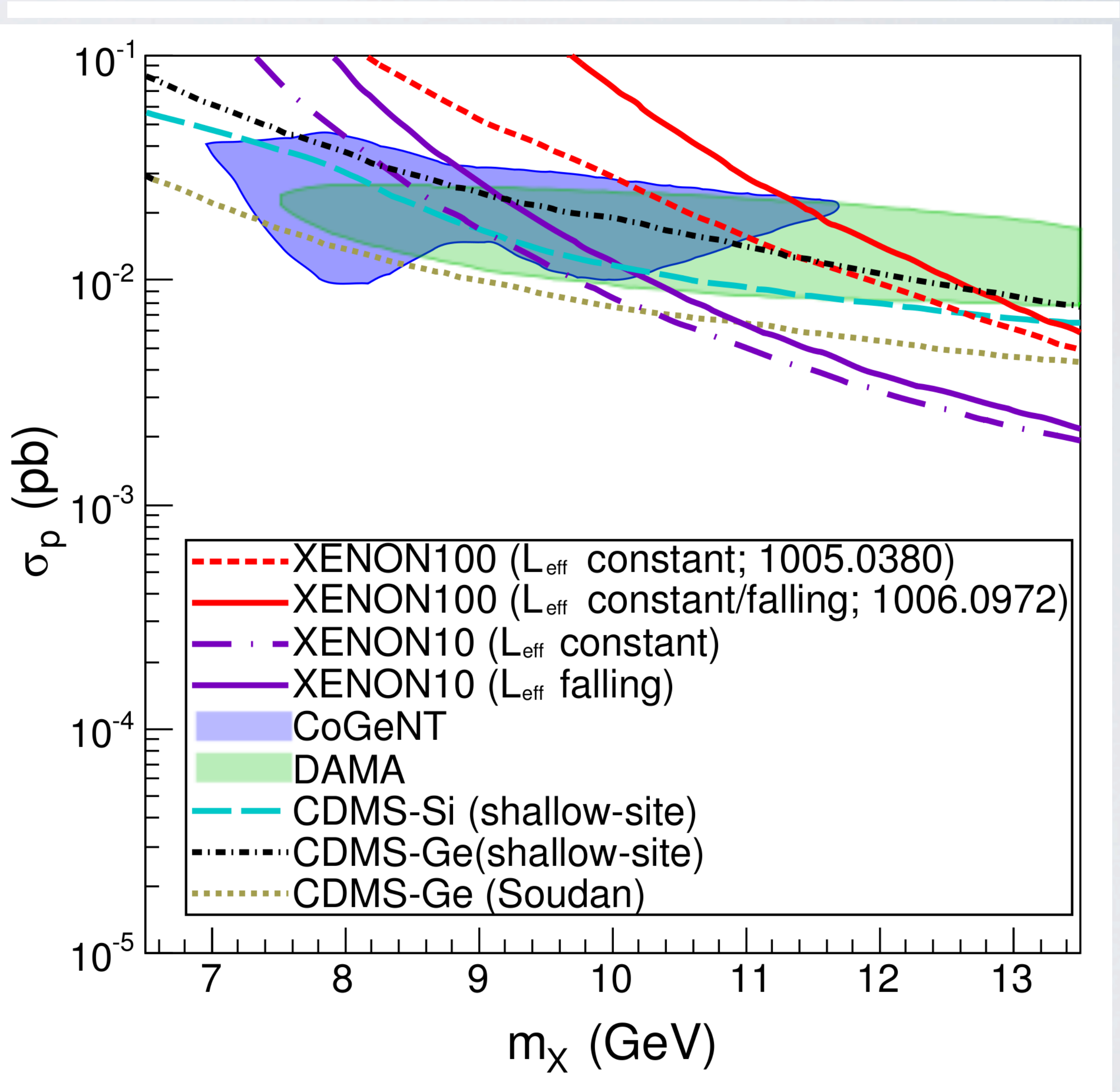


Herrero-Garcia, Schwetz, Zupan '12

SHIFT COUPLINGS TO HELP?

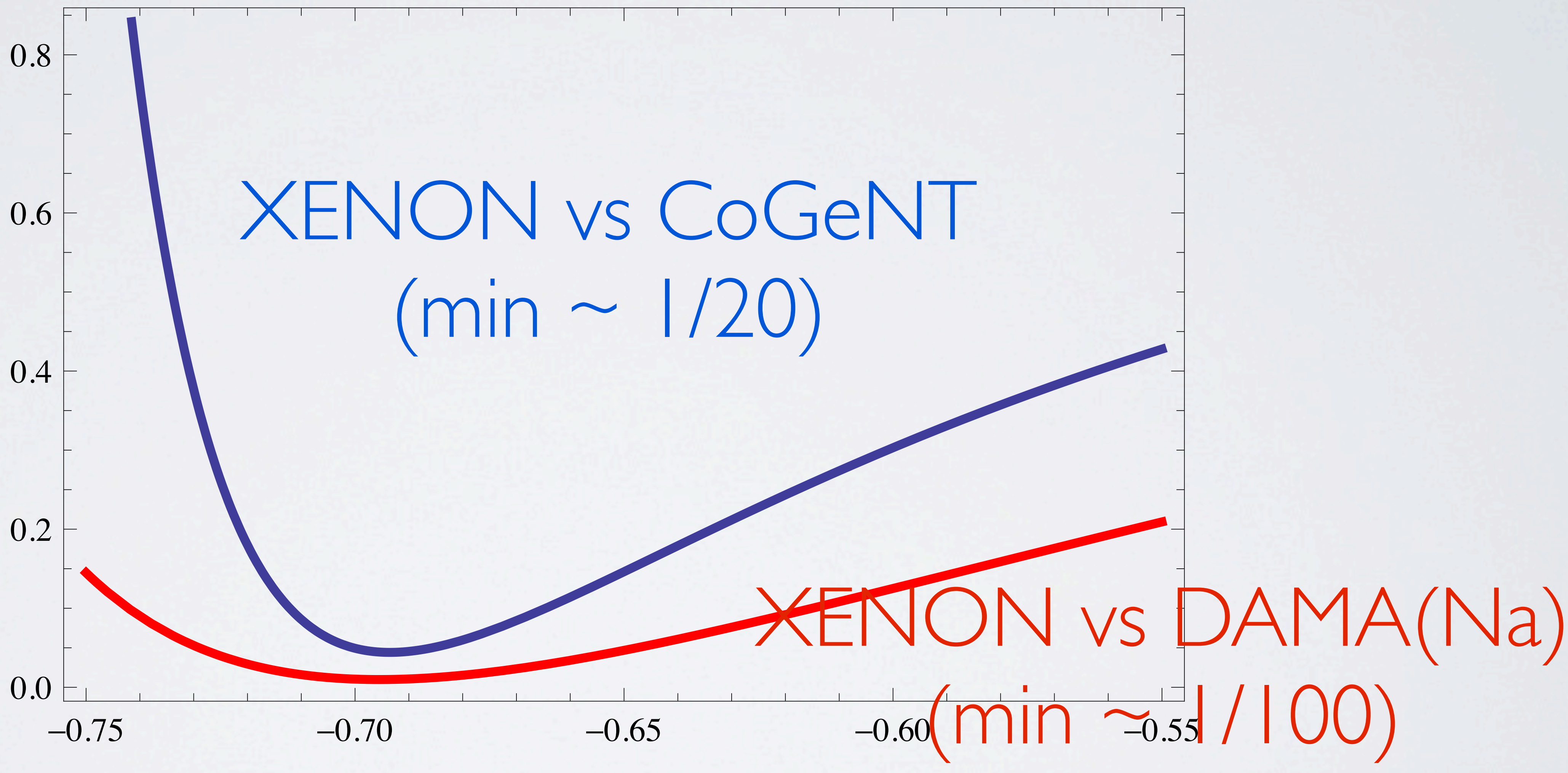


Chang et al 1004.0697



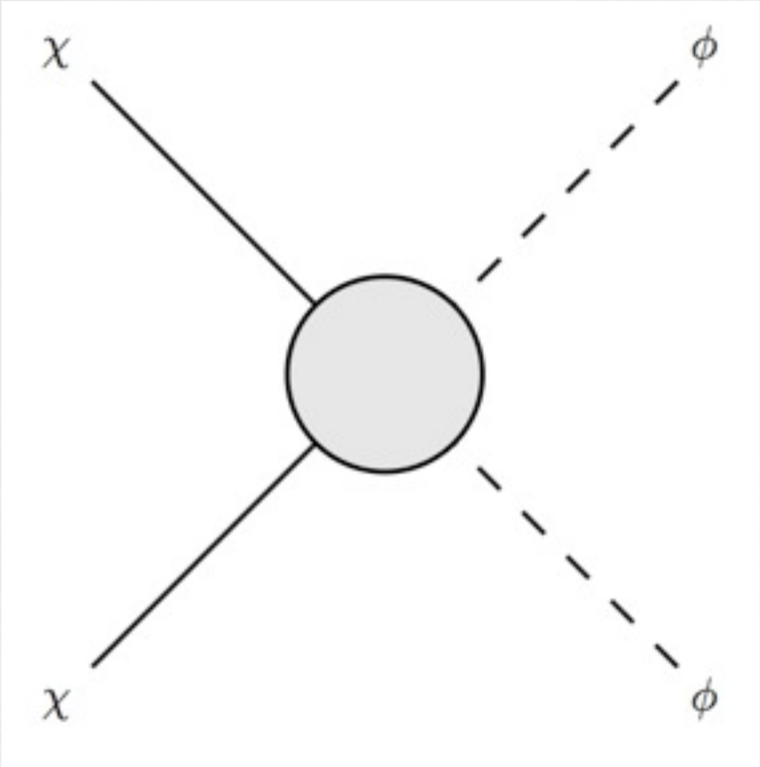
Feng, Kumar, Marfatia, Sanford 1102.4311

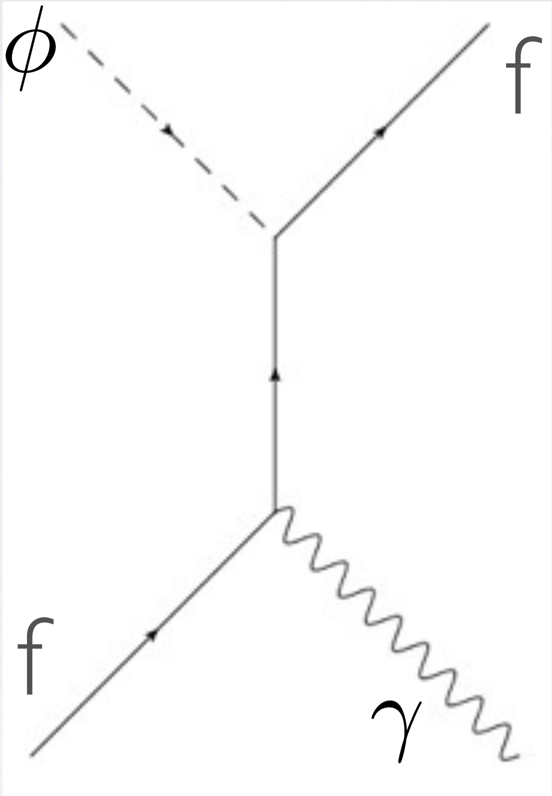
SHIFT COUPLINGS TO HELP?



CDMS-Si (conservatively) is tough though

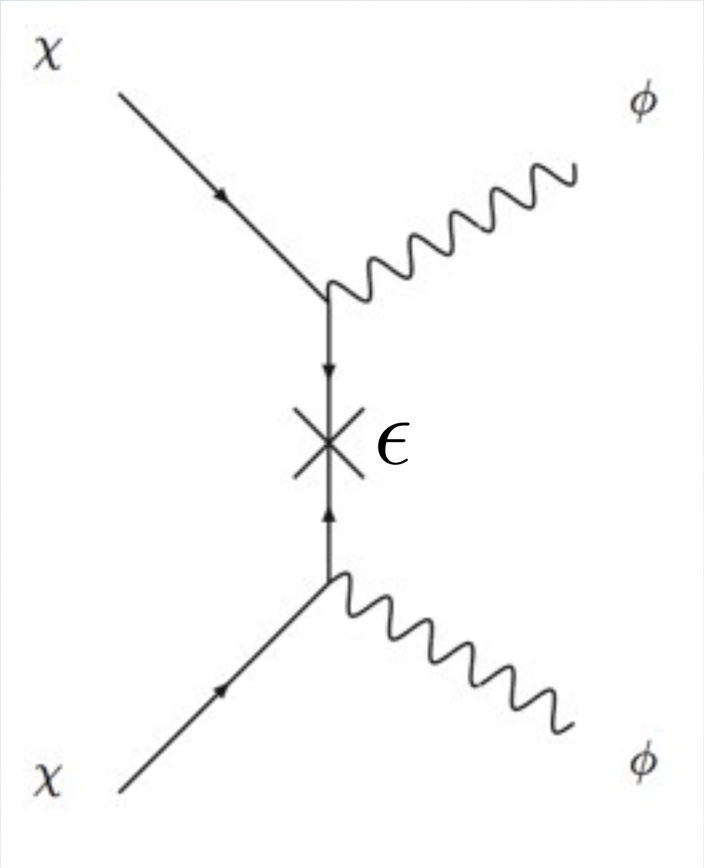
MODELS OF LIGHT DARK MATTER

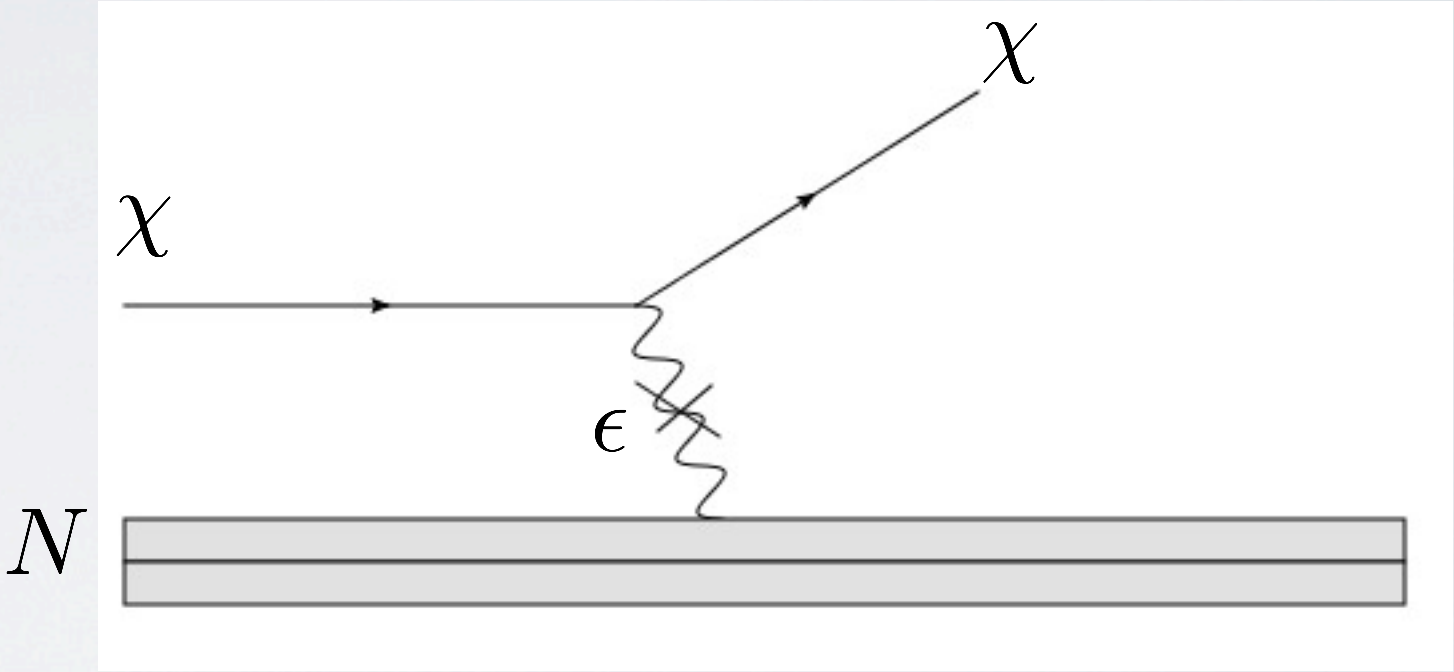




Even with interaction strengths ~ 10^{-8} x SM can maintain equilibrium

MODELS OF LIGHT DARK MATTER





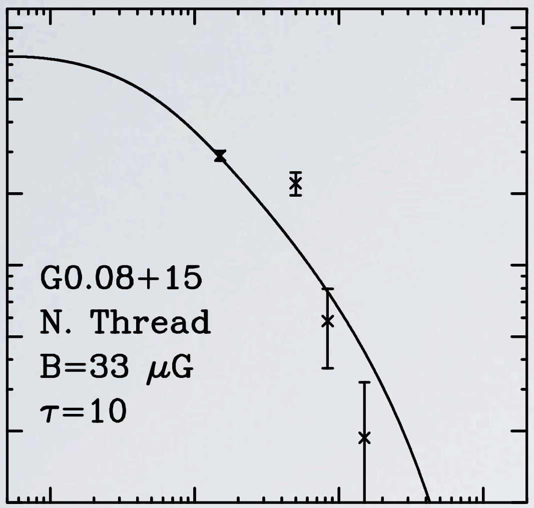
$$\sigma \approx \frac{\alpha_d^2}{m_\chi^2}$$

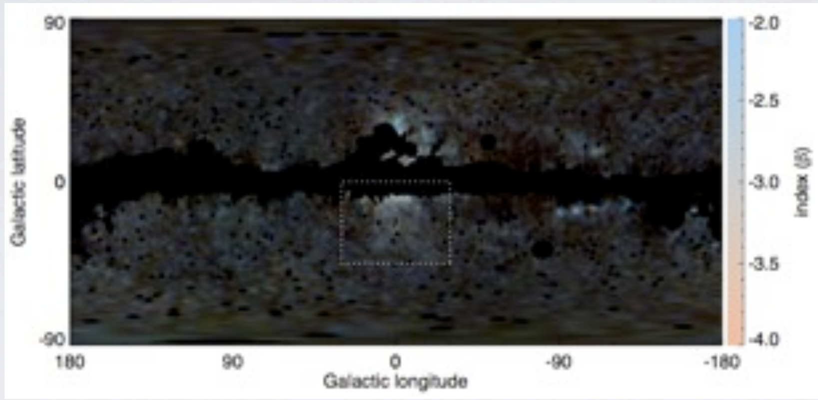
$$\sigma \approx \frac{\alpha_d \alpha_{EM} \epsilon^2}{m_\phi^4}$$

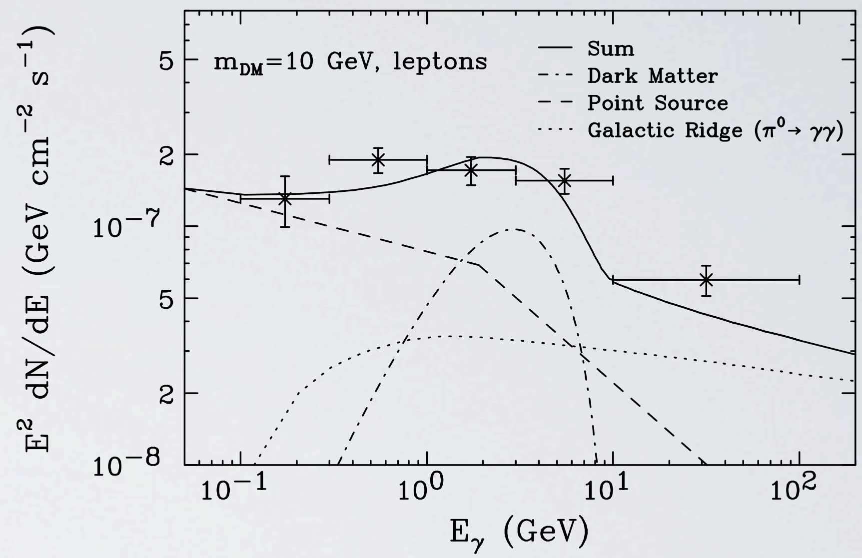
Better chance of seeing with a vector portal

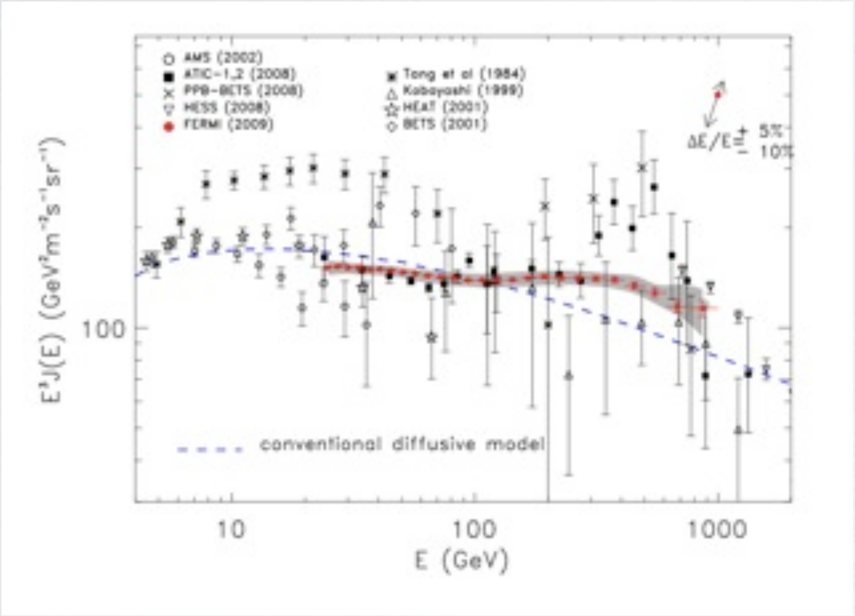
mass can be anything - not necessarily the LSP

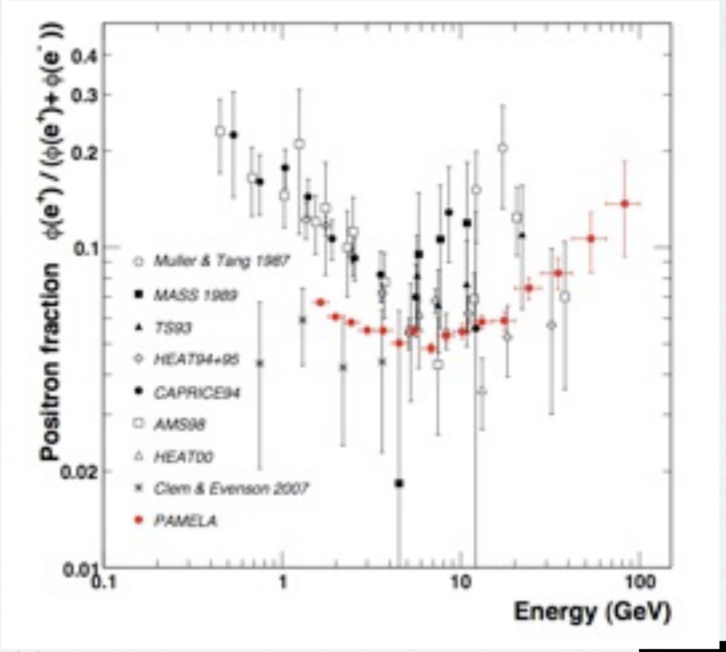
THE ERA OF DATA (2)



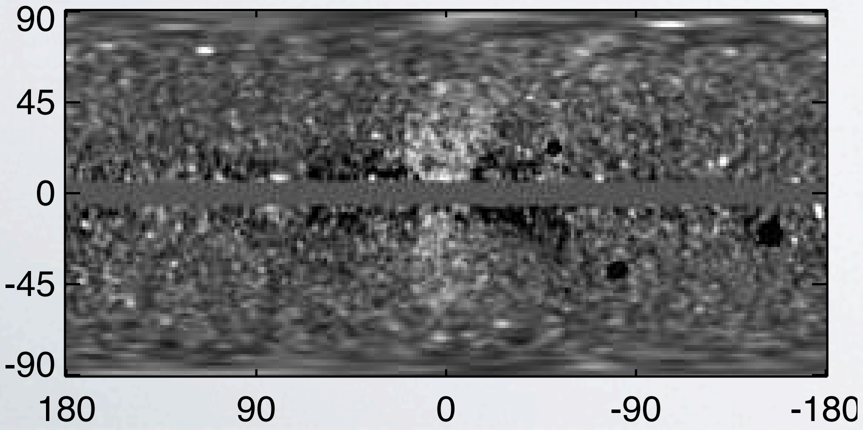


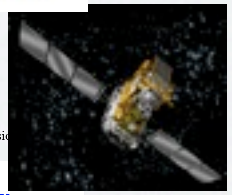


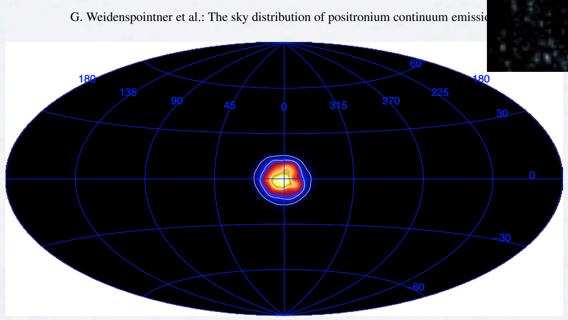


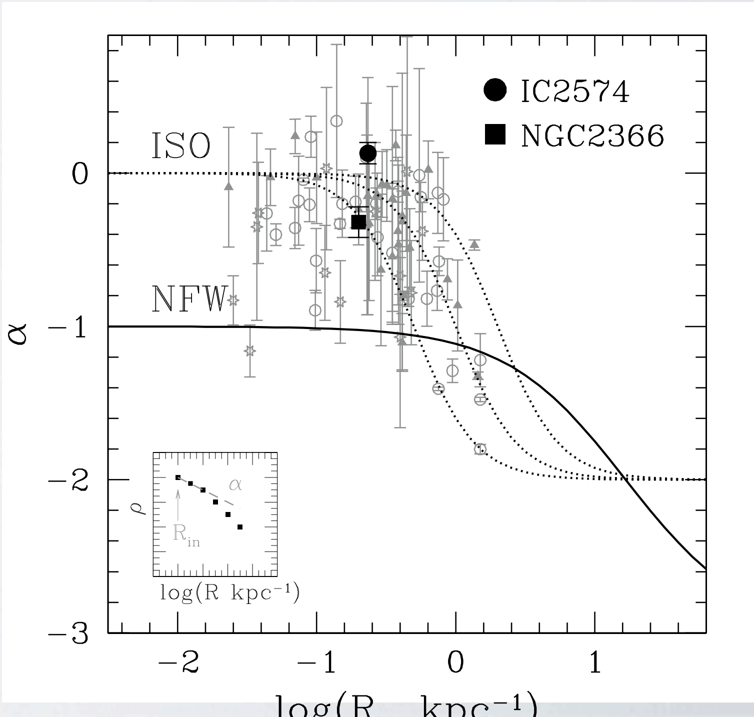


5 GeV < E < 10 GeV residual

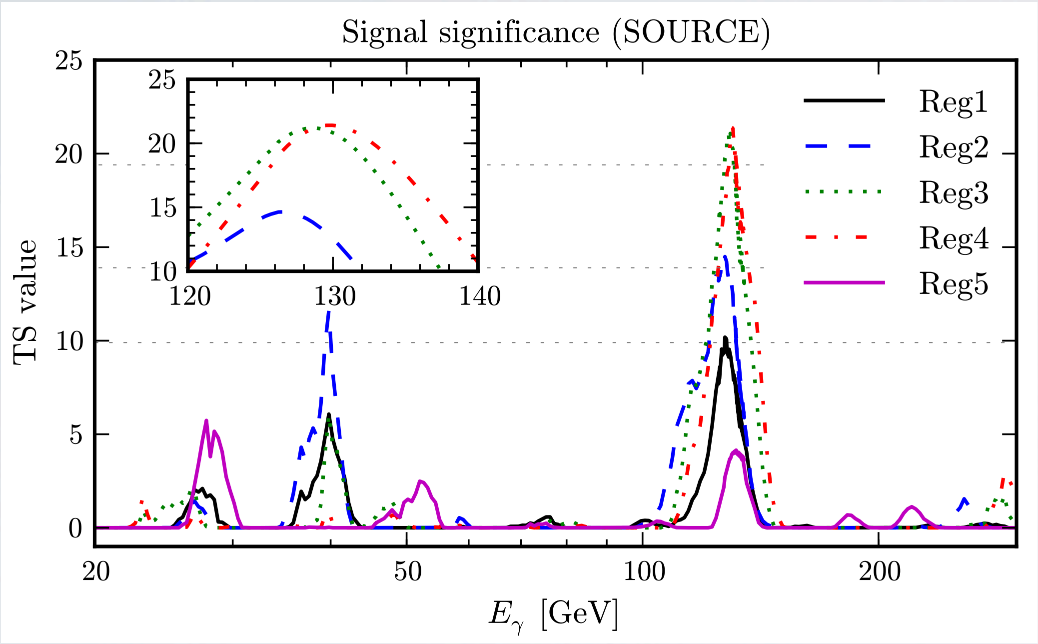


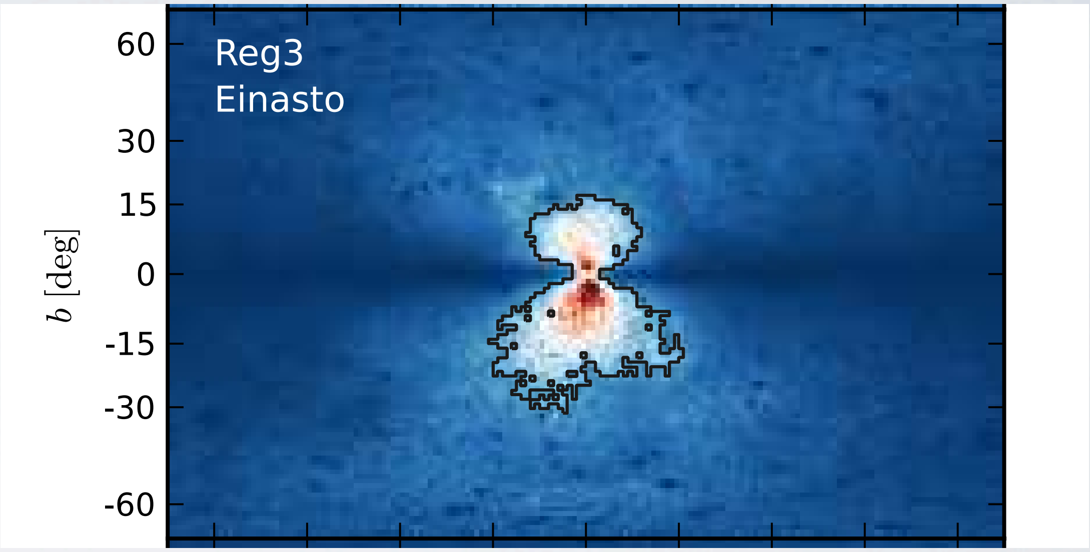


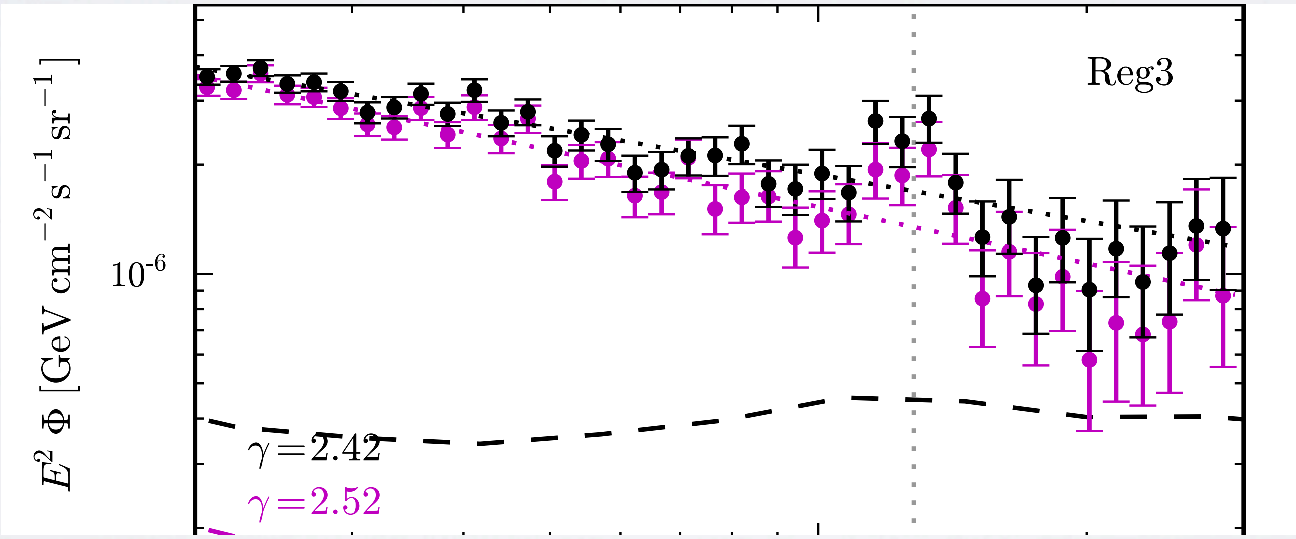




ANOMALIES IN THE SKY

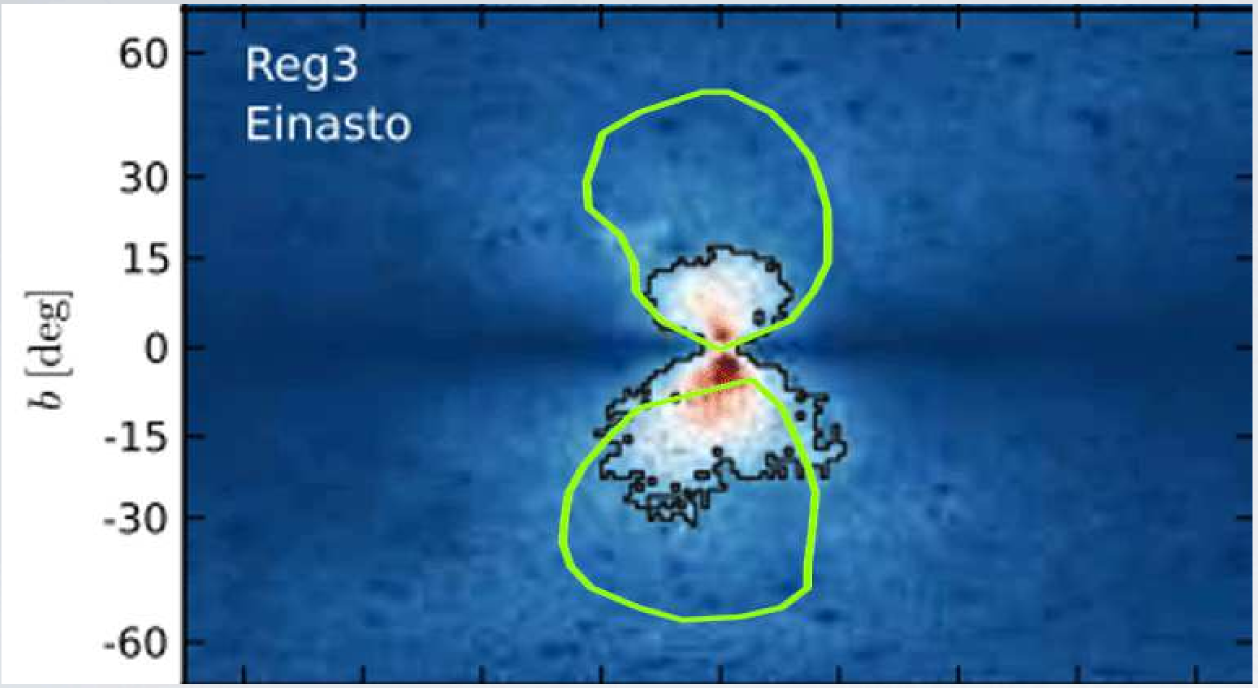






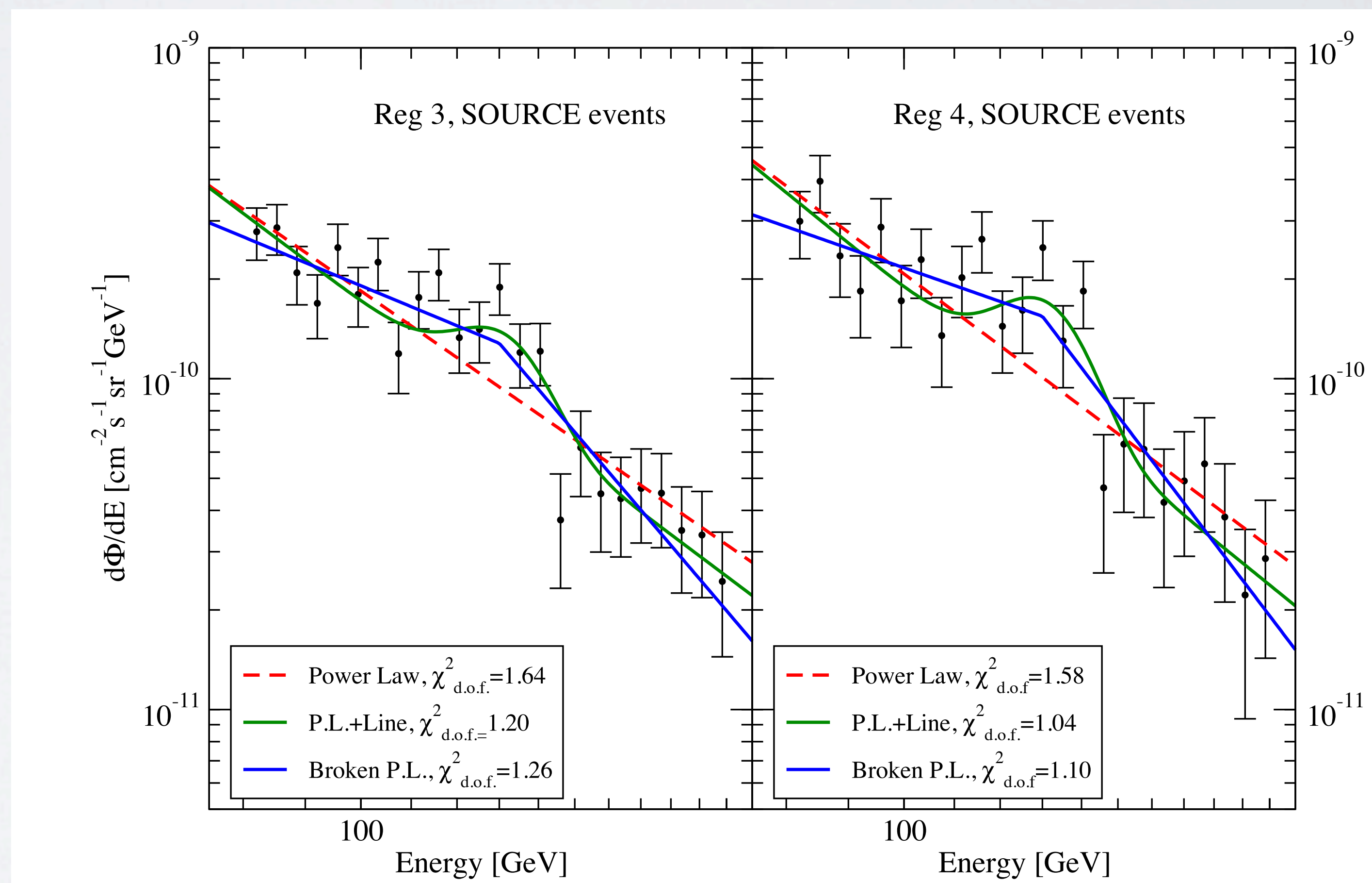
At last, a line!

Weniger '12



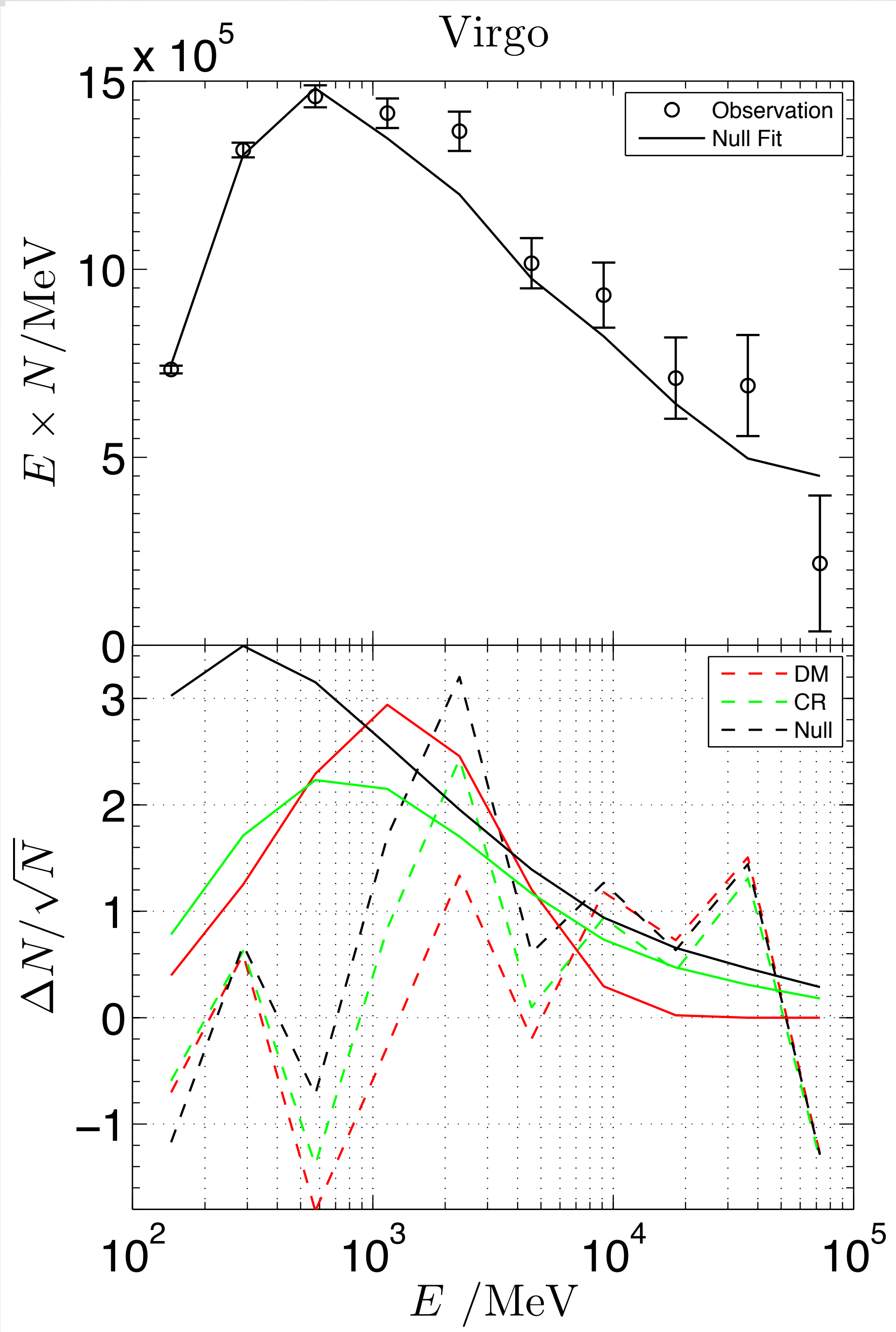
At last, a line?

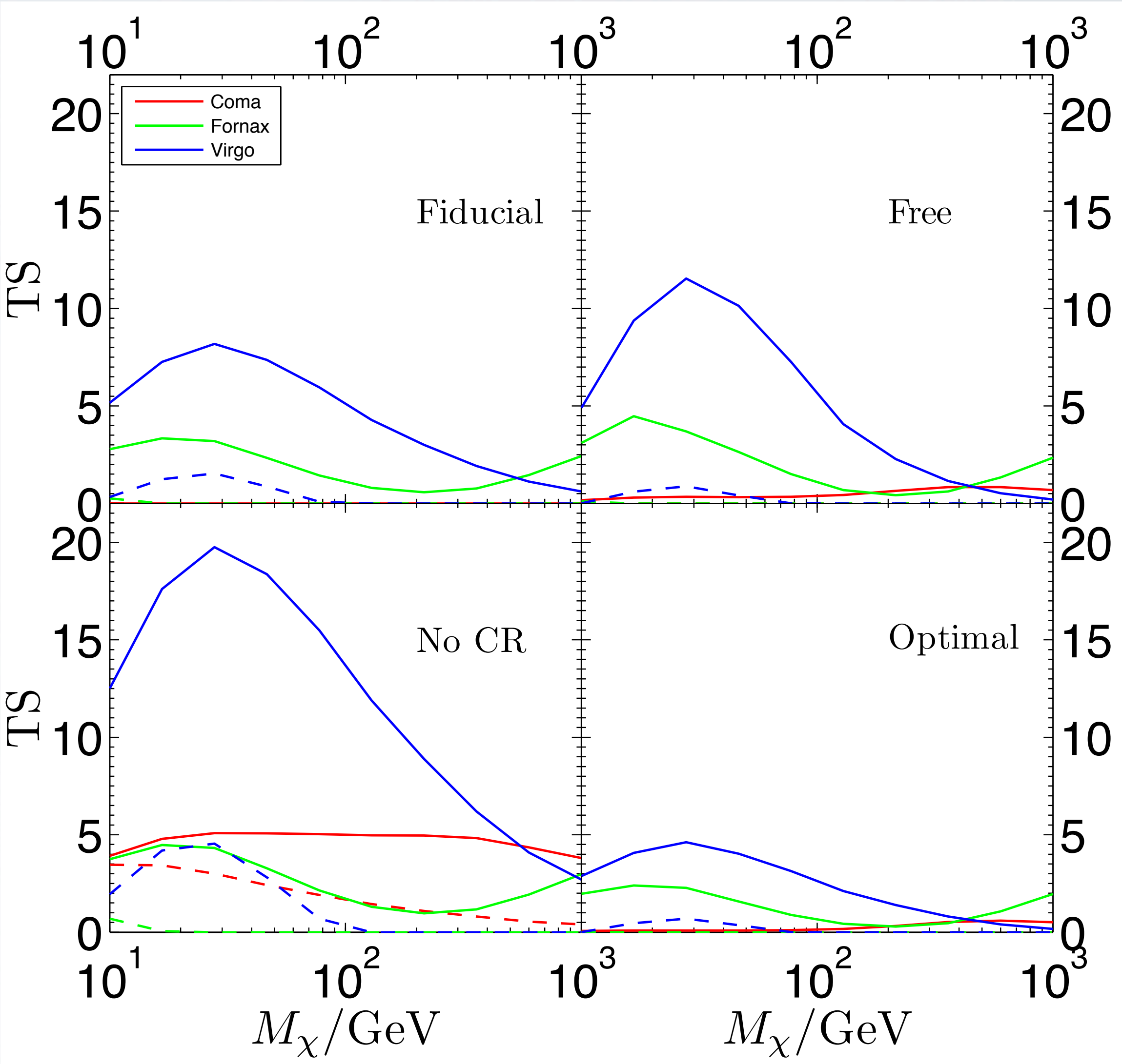
Linden + Profumo '12



Alternatively interpreted as : gamma gamma, gamma Z, internal bremsstrahlung, 4 gamma

EXTENDED EMISSION

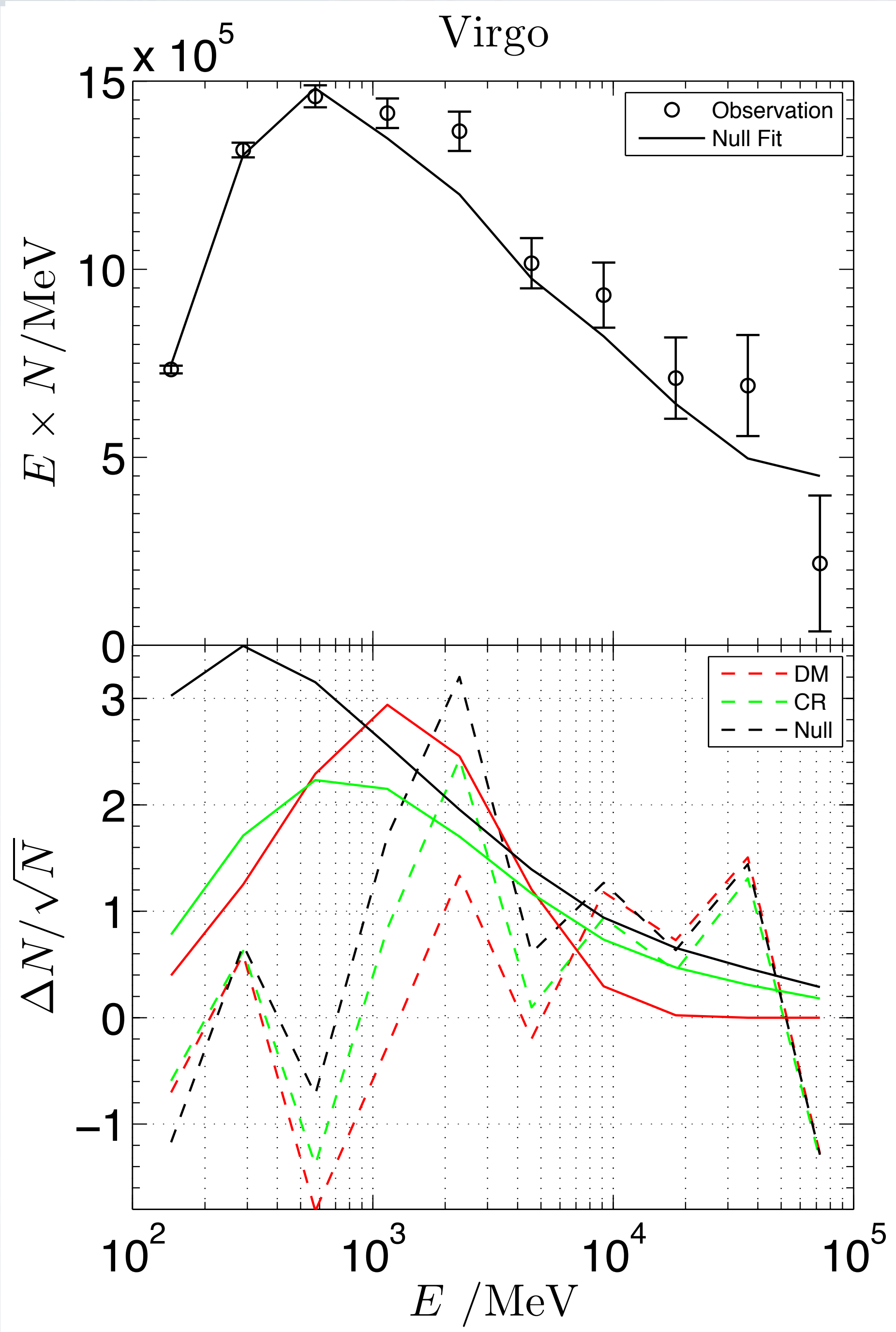


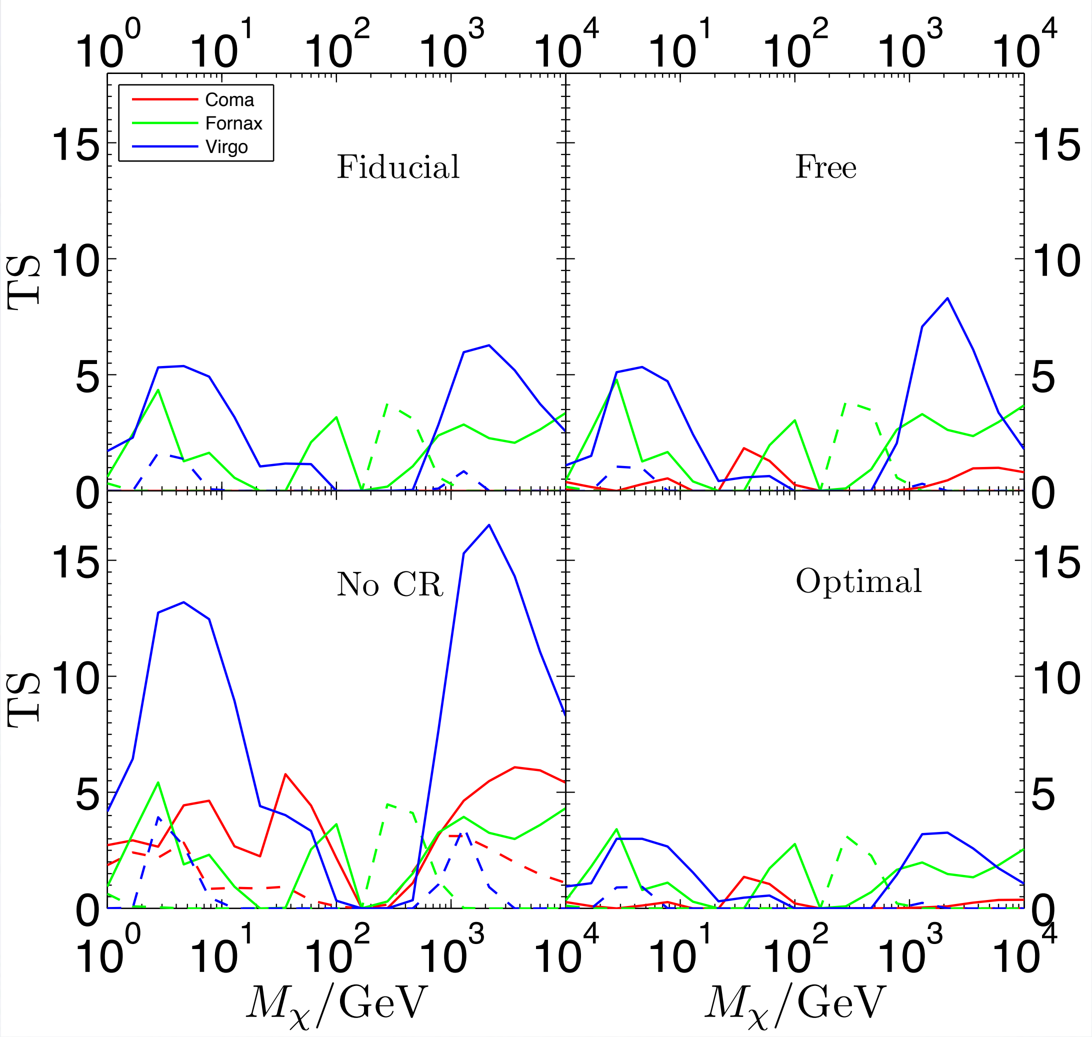


b b

Han et al '11

EXTENDED EMISSION



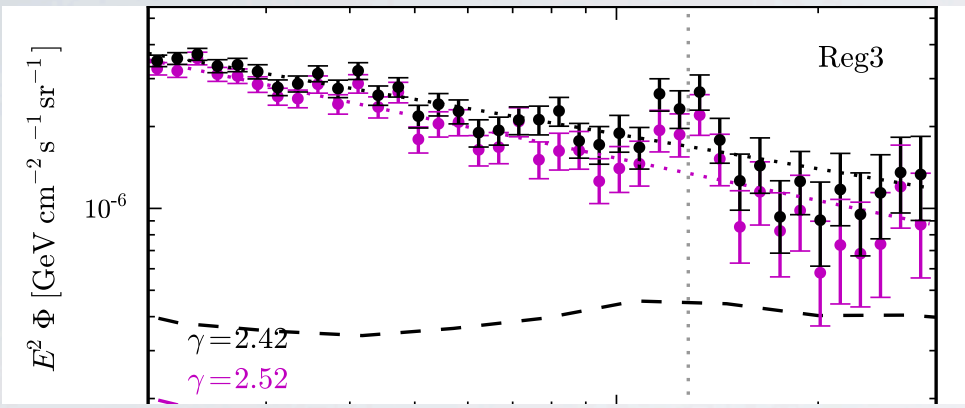


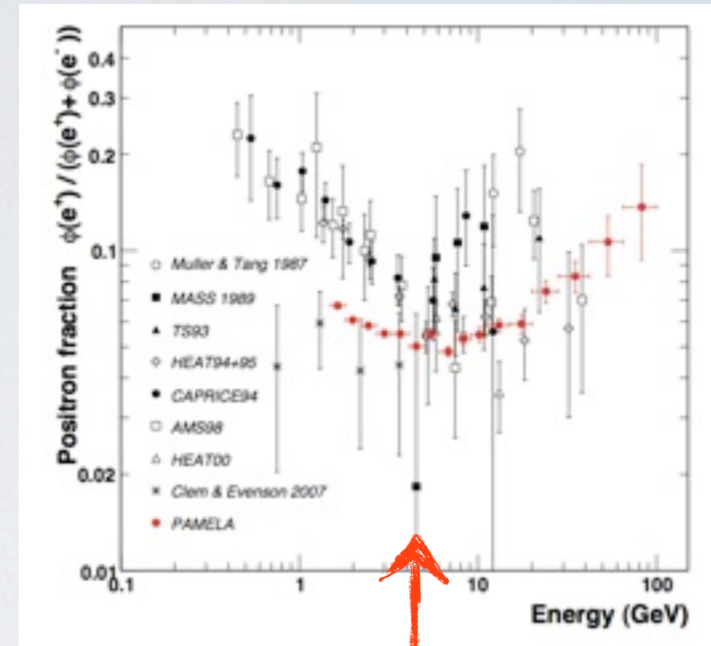
mu+mu-

Han et al '11

THE CURSE OF PLAUSIBILITY

I like Wino dark matter!

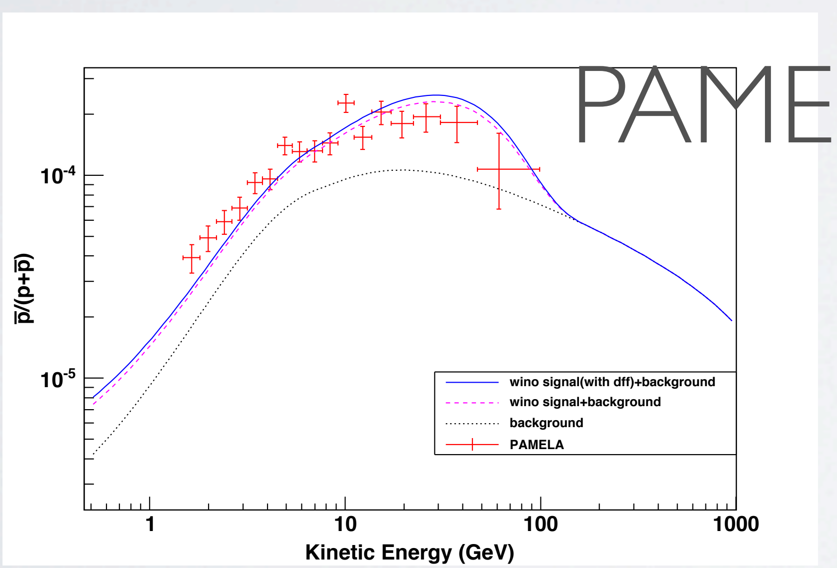




gamma-Z !

PAMELA!

7



PAMELA!

Higgs at 125!

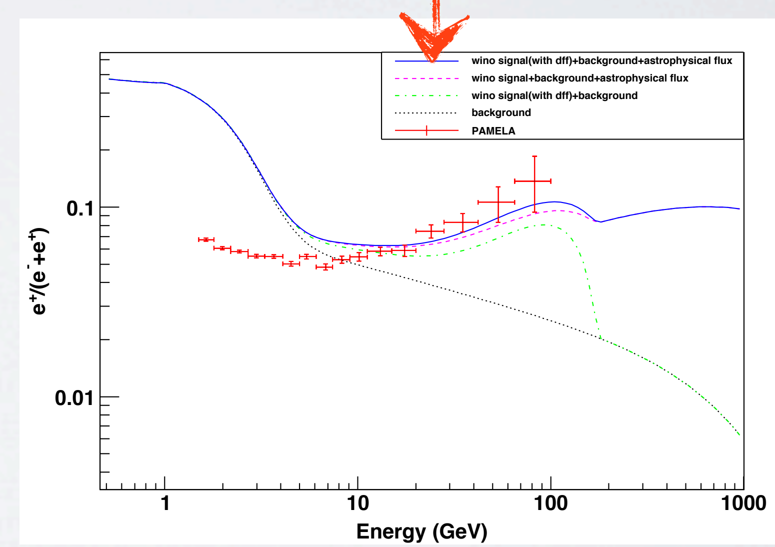
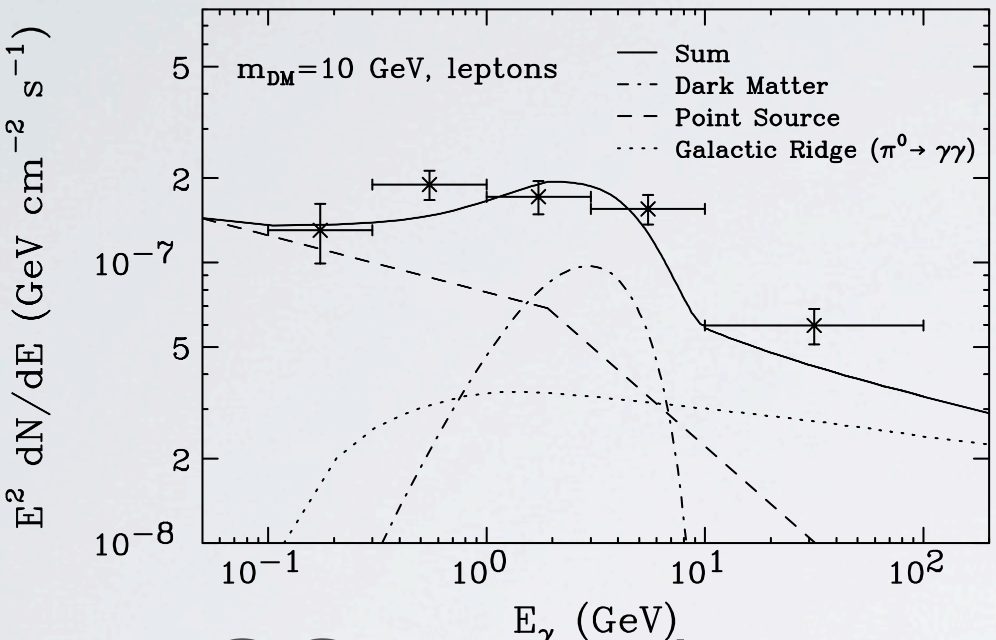


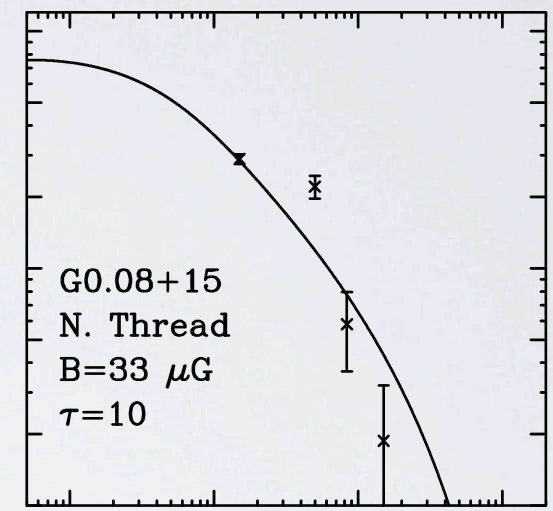
FIG. 2: The antiproton flux ratio. The solid line is the ratio of the total antiproton flux, which include the antiproton from wino annihilation, and conventional astrophysics background, the dash line has the same components but without the density fluctuation factor, the dot line is astrophysics background only. The data are from PAMELA [23]. At the PAMELA meeting in Rome[20], data was reported with the last bin increased by 70%, and a bin up to 185 GeV with three events, but we do not show the data since it is not published. Note the signal is larger than the background down to very low energies.

THE CURSE OF PLAUSIBILITY

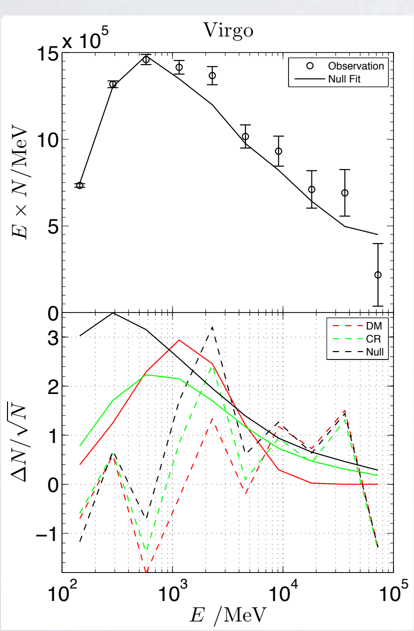
I like light WIMPs!

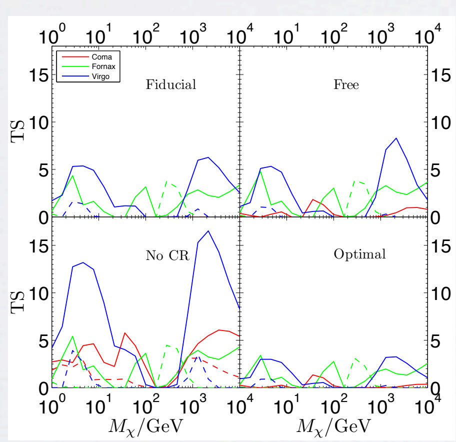


GC excess!

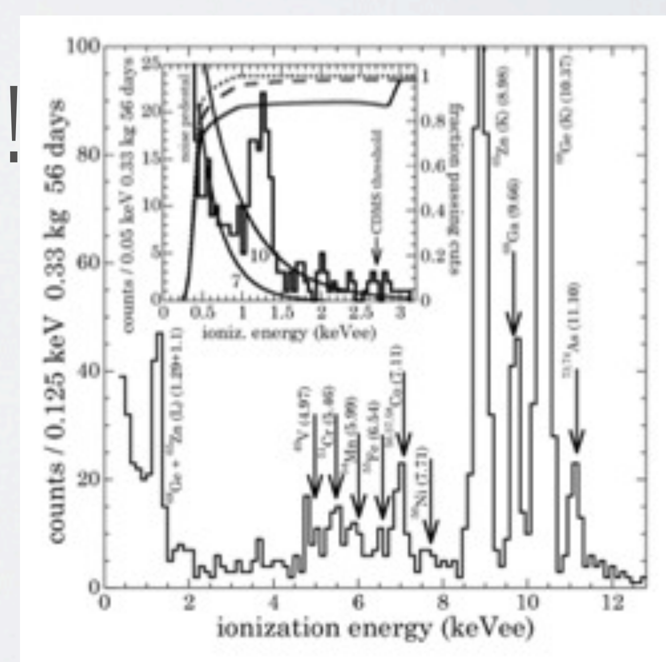


Radio filaments!





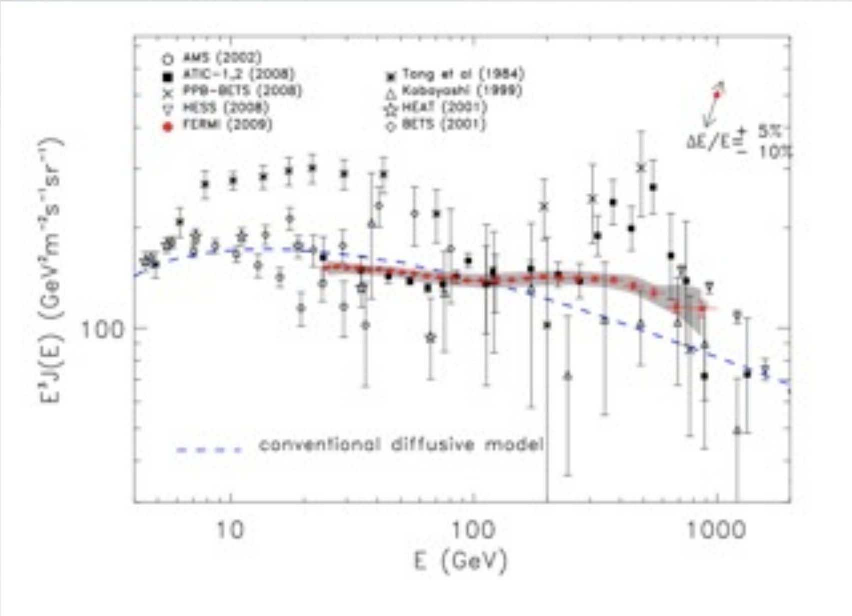
Direct detection!

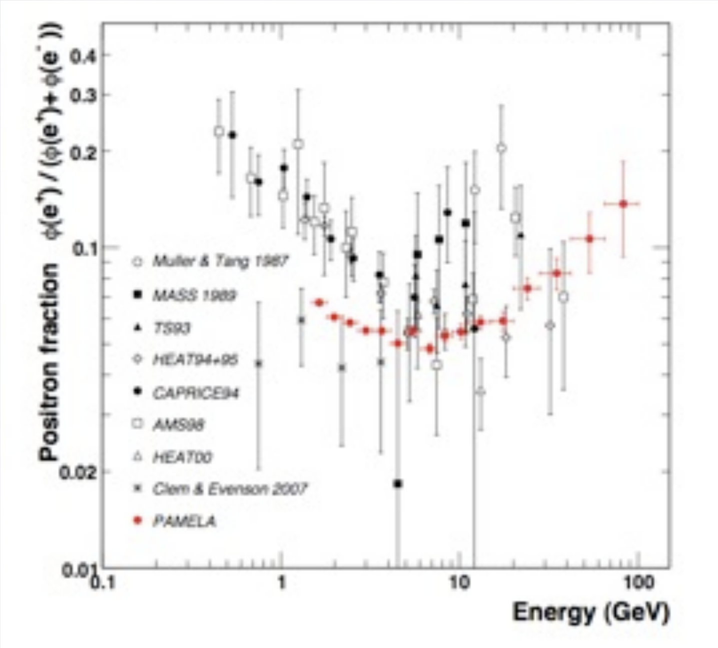


extended emission!

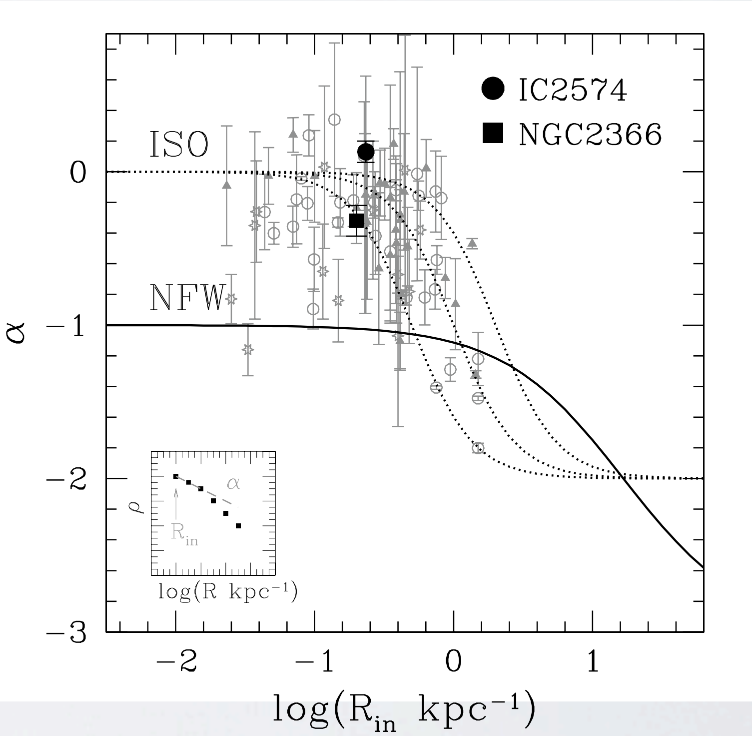
THE CURSE OF PLAUSIBILITY

I like Dark Force WIMPs!

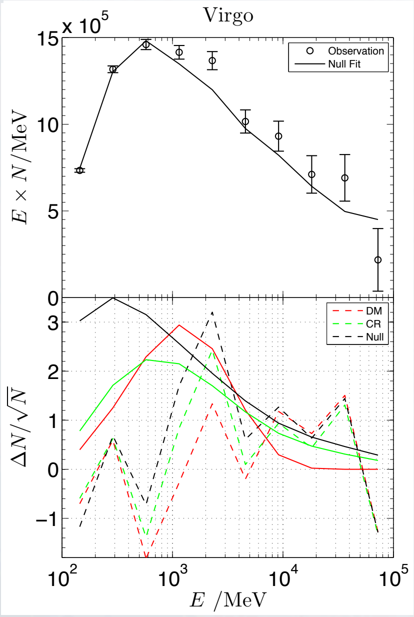


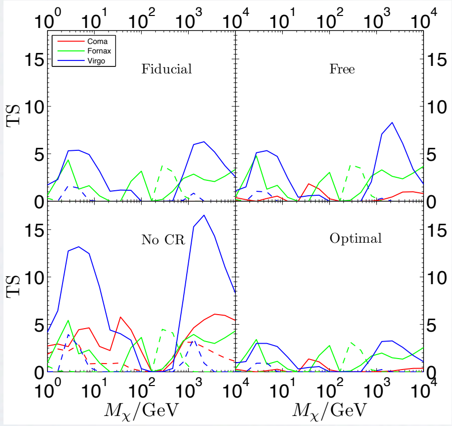


Positrons!



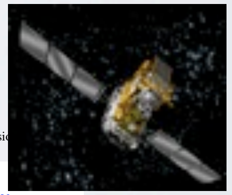
cores!

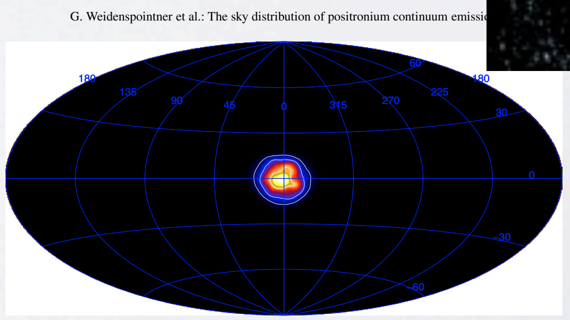




extended emission!

INTEGRAL!





THE CURSE OF PLAUSIBILITY

- The Sky has become the dominant source of data that motivates our thinking
- But it is also the region with the largest uncertainties
- We are not getting any definitive support from LHC or DD (yet)
- I can tell plausible stories that dark matter has been discovered
- I can tell plausible stories about astrophysical backgrounds

QUESTIONS

- What anomalies *could* be dark matter?
- What will convince us that they're really DM? What would convince us they really are not?
- And I don't mean some pie-in-the-sky amalgam of data, because it doesn't appear it will be like that
- And don't say a line

CONCLUSIONS

- Midway through the era of data it is either a major disappointment or succeeding beyond our wildest expectations