Gaugino physics in (unorthodox) SUSY

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S.Jung, J.D.Wells: 1312.1802
B.Batell, S.Jung, C.Wagner: 1309.2297
S.Gori, S.Jung, L.T.Wang: 1307.5952

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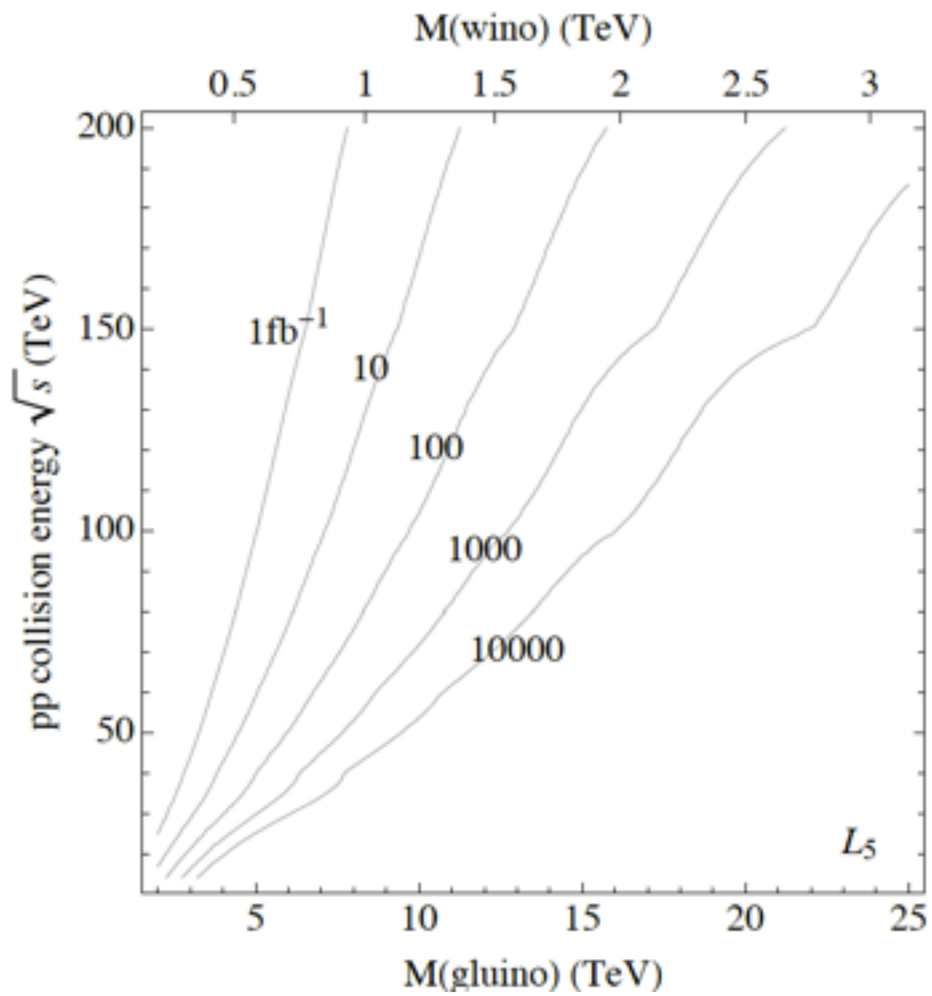
- Pure heavy gauginos in split SUSY (SJ, Wells)
- EWkinos in compressed SUSY (Gori, SJ, Wang)
- Very light displaced gauginos (Batell, SJ, Wagner)

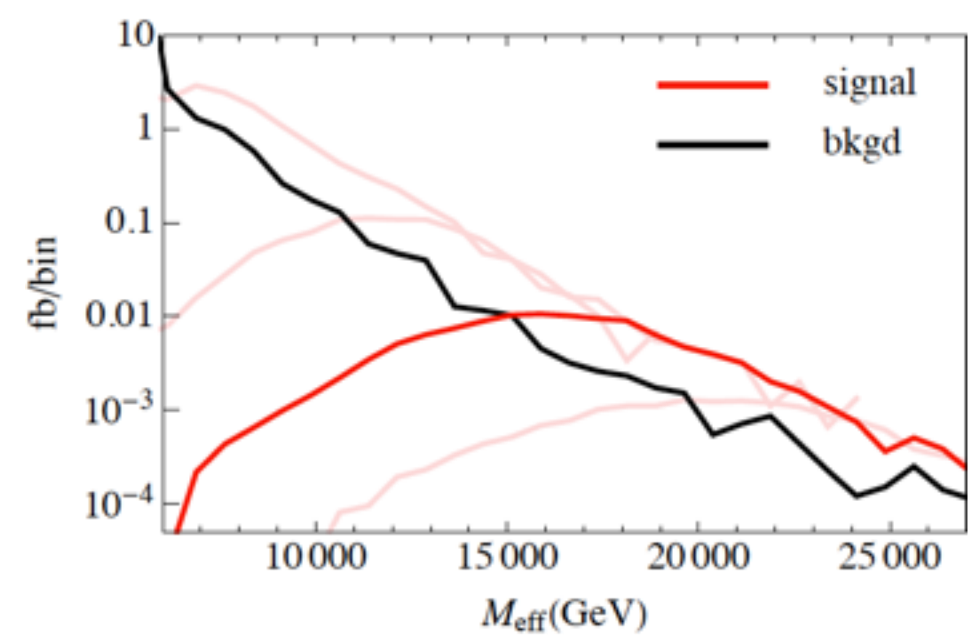
Pure heavy gauginos in split SUSY spectrum

1312.1802, SJ, J.D.Wells

Discovery through gluinos

- An important next mass scale of SUSY is 1TeV~3.1TeV where LSP can be thermal DM.
- Meff from gluino pair production works.
- Discovery relies on gluino mass and gluino-to-LSP mass ratio.
- ~200TeV pp collider is needed for AMSB 3.1TeV LSP.



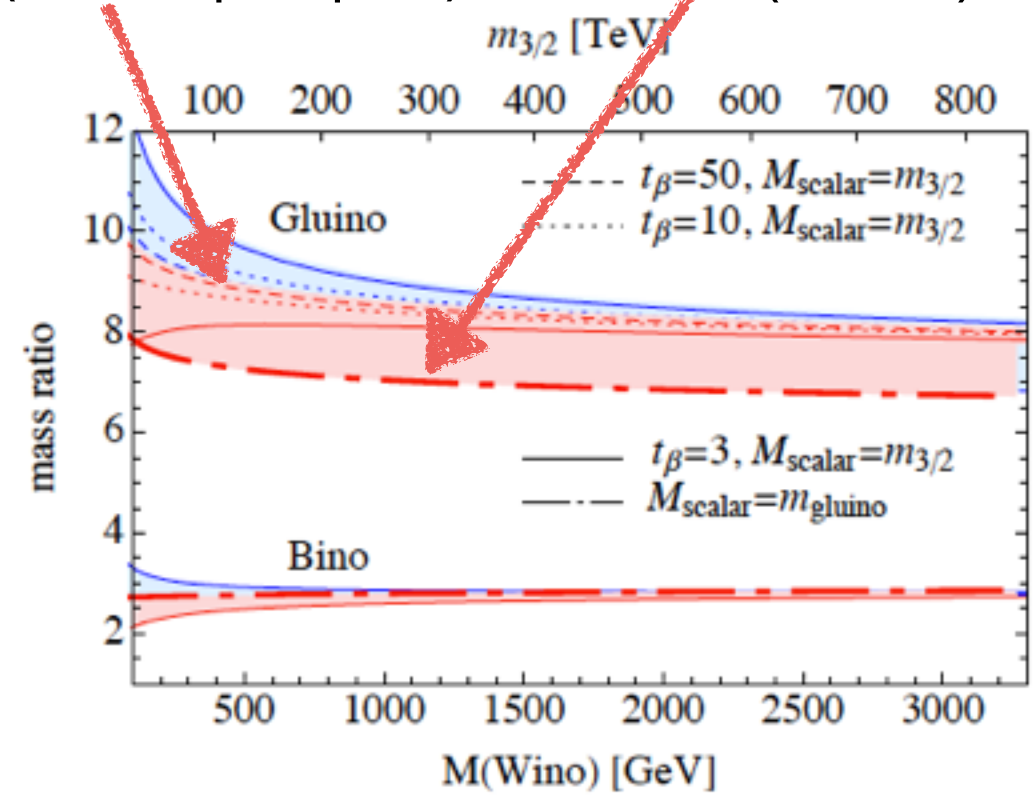


Quantum corrections to gauginos

- Large scale separation between scalar and gauginos lead to large quantum corrections to gauginos.
- One-loop heavier sfermions already shift LO ratio by 20-30%.
- Heavy higgsinos have further big impact as gauginos and higgsinos mix via RGE.

heavy scalars (1-loop split)

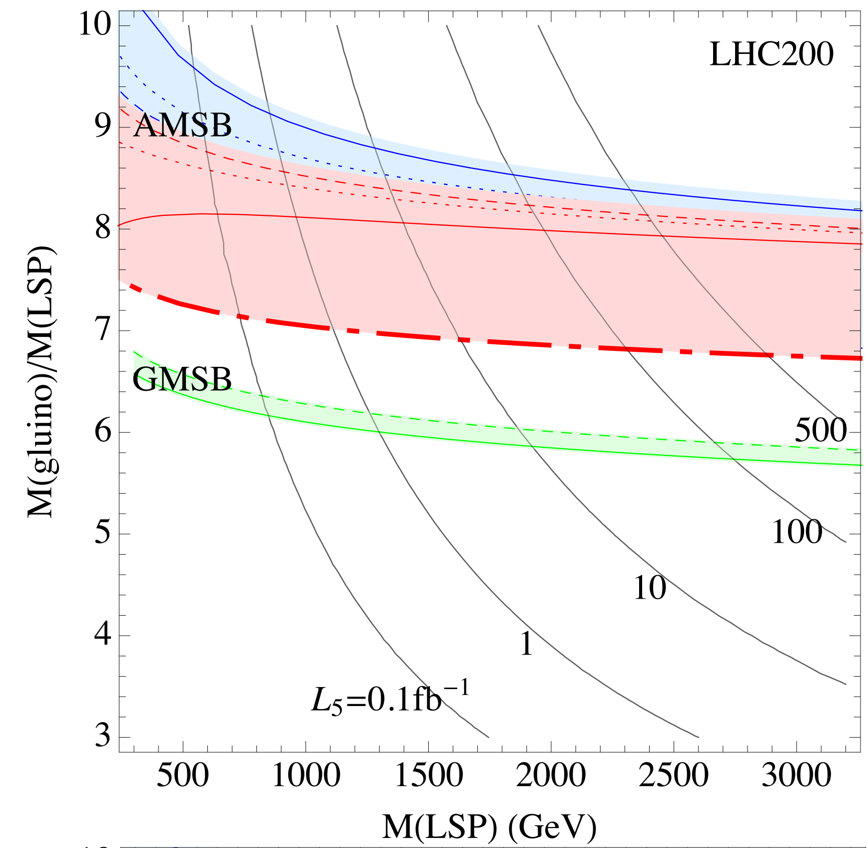
light scalars (~LO)

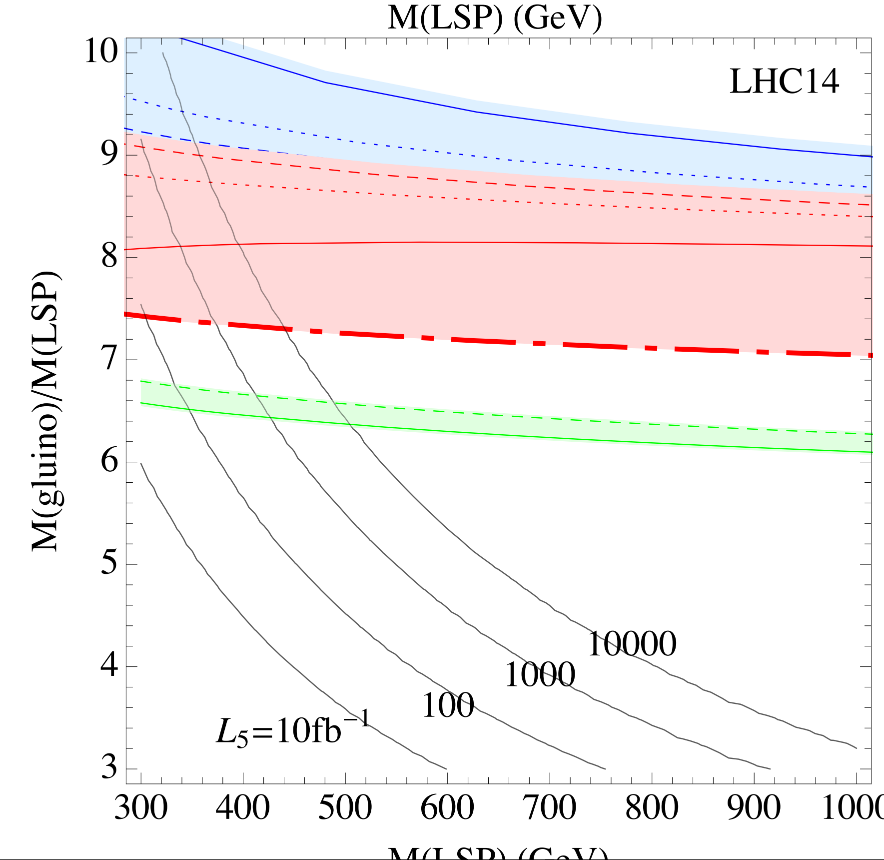


$$\delta M_2(pole) \sim -\frac{\alpha_2}{8\pi}\, 2\mu\, \sin 2\beta\, \log \frac{\mu^2}{m_0^2}$$

Discovery vs. gaugino mass ratio

- A useful model-ind. presentation.
- AMSB perhaps is most difficult for discovery while NLO model uncertainty can be large.
- Mirage mediation needs other discovery channels.
- Higgsino LSP has no definite coverage.



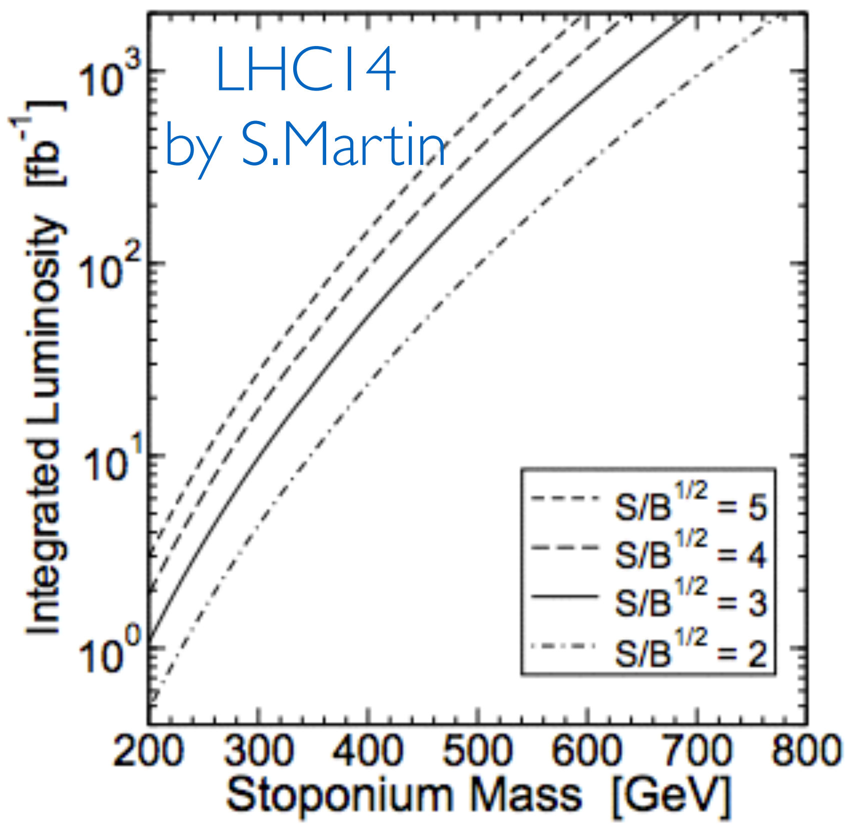


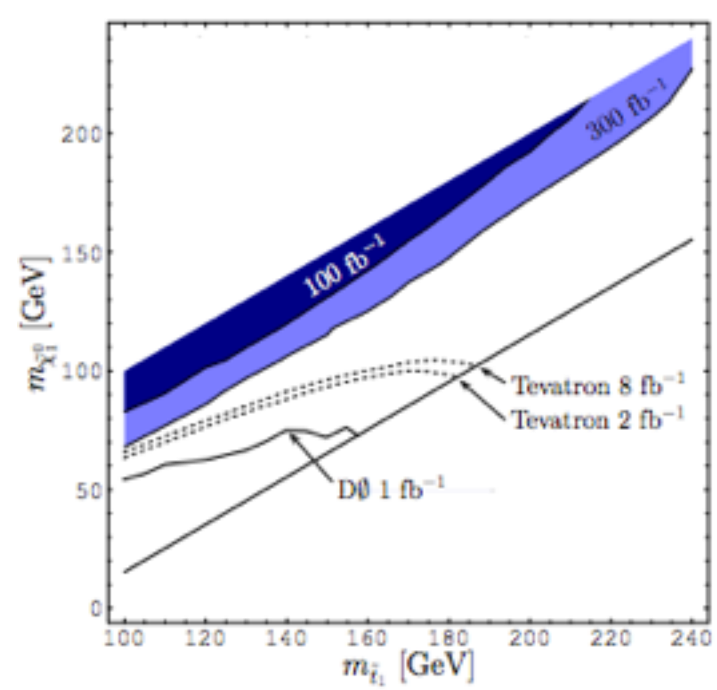
EWkinos in compressed SUSY

1307.5952, S.Gori, SJ, L.T.Wang

Compressed spectrum searches

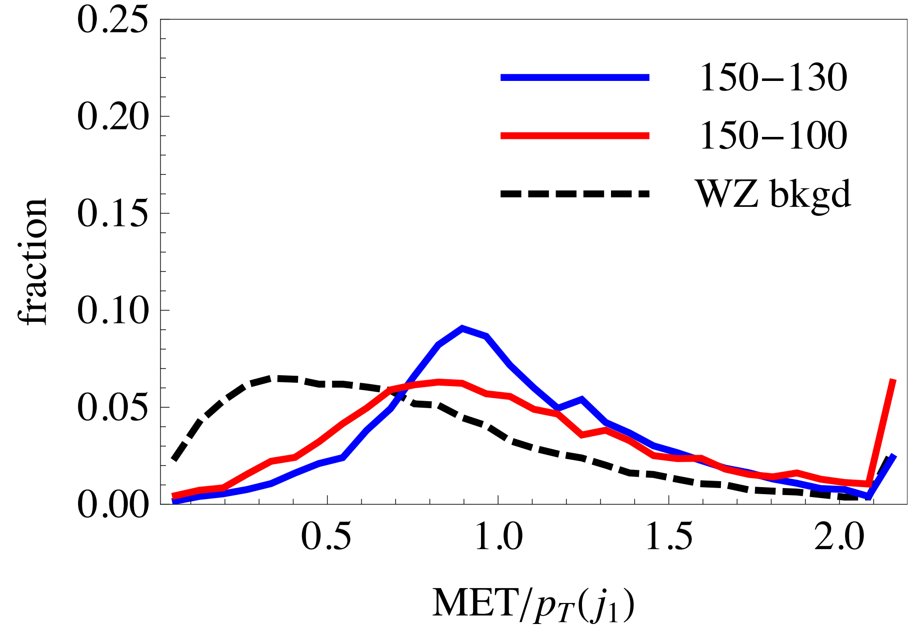
- Monojet/photon +MET: simply one hard jet + large MET.
- Bound states: stoponium is clean, works for any small mass-gap. But wimponium production is small.
- We introduce new variables: correlations and boosted kinematics with other visible particles too.

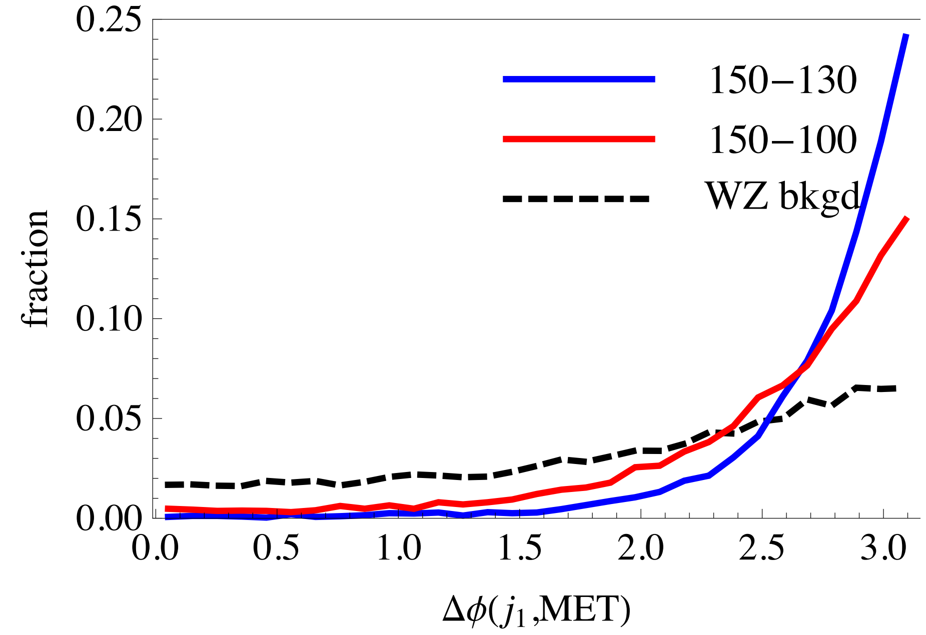


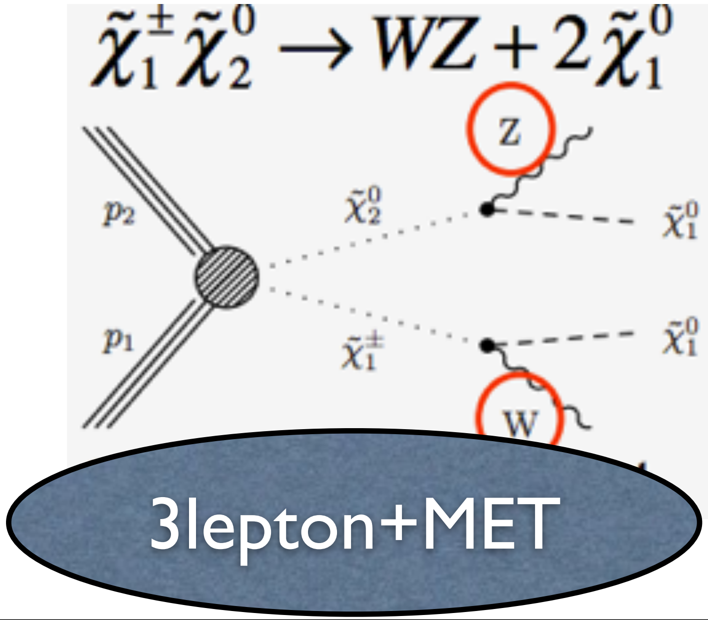


Correlation of ISR and MET

- ISR generates useful correlations in addition to simply large pT.
- Large MET arises only from hard ISR. Their momentum size and directions are correlated.

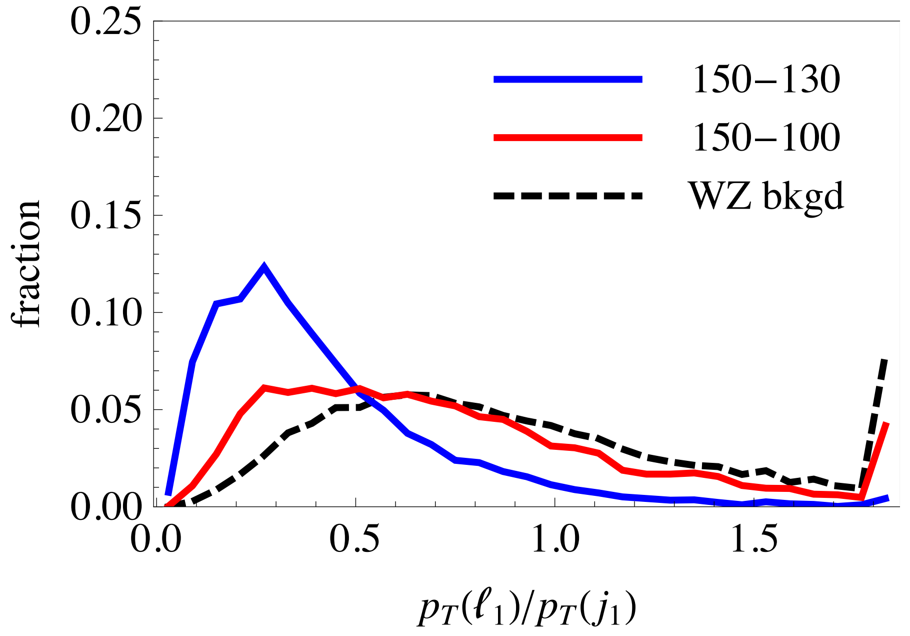


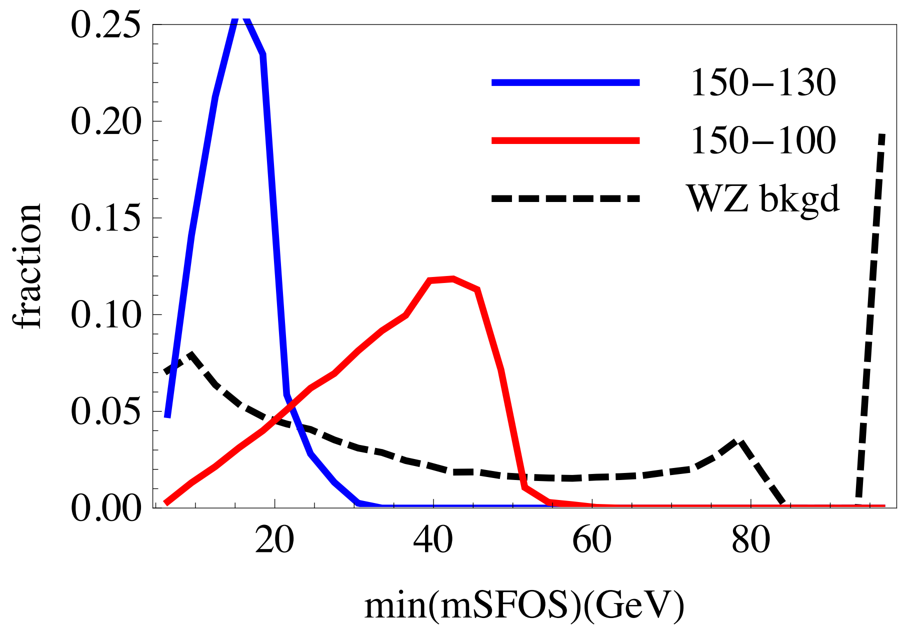




Leptons carry mass-gap info

- Not-too-small mass splitting will produce hard enough leptons too.
- Leptons tend to stay softer compared to ISR than those from background.
- A new variable, min(mSFOS), presents a clear kinematic upper limit.



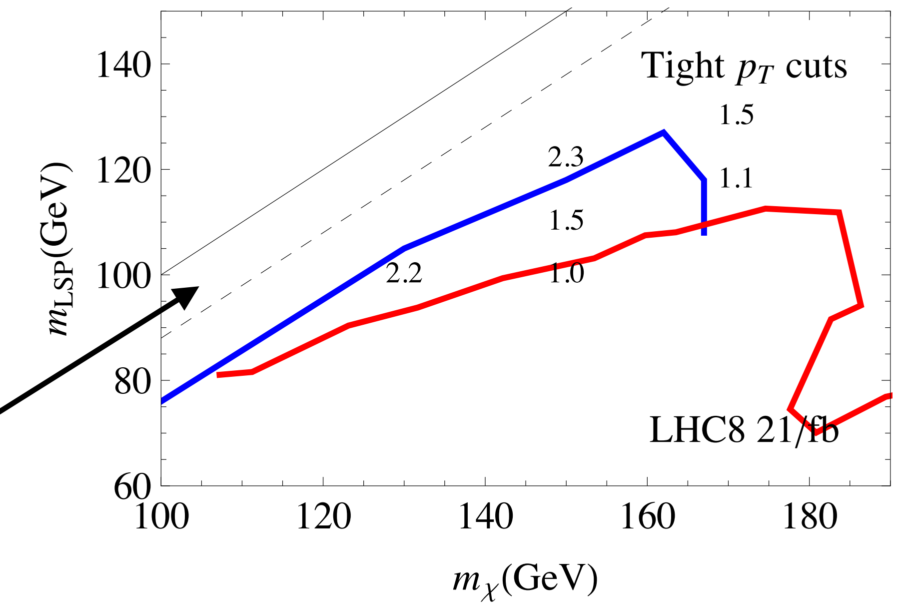


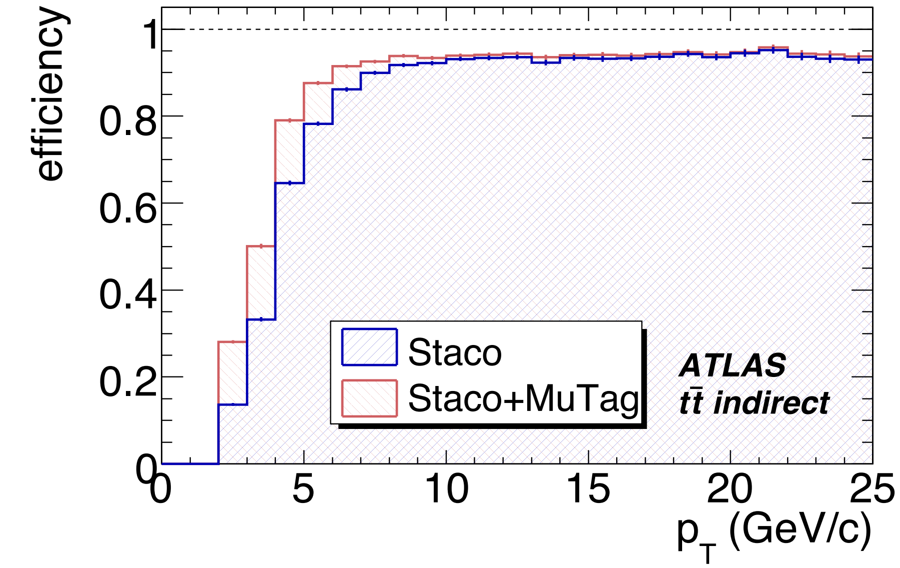
Limitations

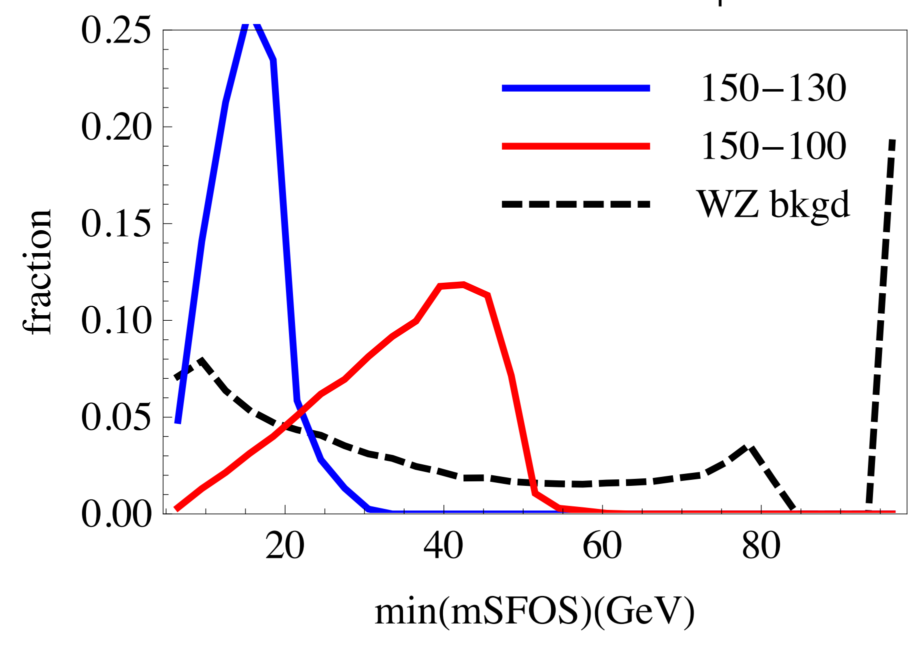
- Soft leptons and small mSFOS cannot be used with arbitrarily small mass splitting.

- (1) triggers, bad recon. of soft leptons.

- (2) low-mass hadronic resonances <~10GeV and off-shell photon conversion.





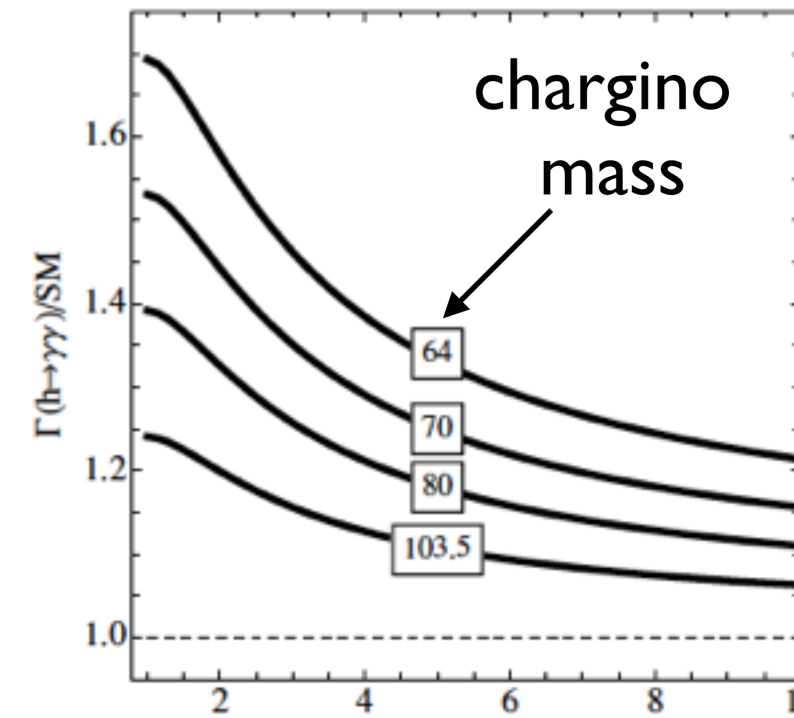


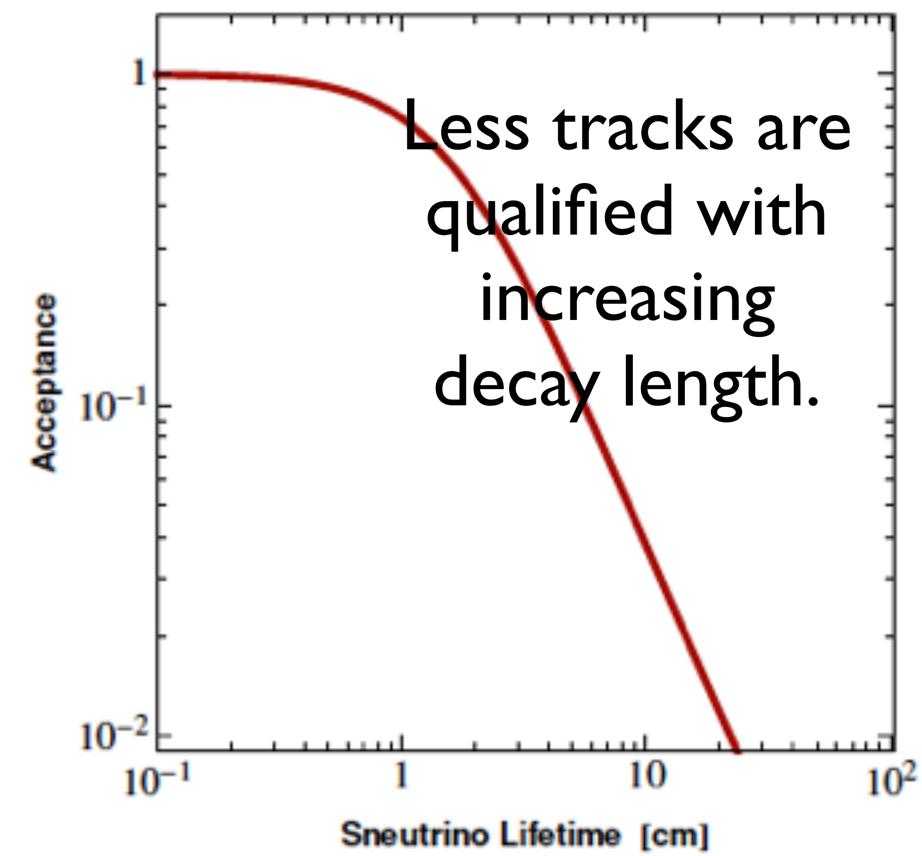
Very light displaced gauginos

1309.2297, B.Batell, SJ, C.Wagner

Sub-100GeV, displaced

- Sub-100GeV charginos would significantly affect Higgs decay.
- Did LEP really rule out them?
- LEP trigger based on # of good tracks. Displaced decay reduces it.
- Bad tracks are likely neutral hadrons(not MET) in LEP particle flow algorithm.





A model: sneutrino LSP

- LSP: e-sneutrino. Displaced decay via RPV $\lambda_{121}\ LLE$.

$$\tilde{\nu}_e \to e^- + \mu^+$$

- NLSP: Maximally mixed wino-higgsino chargino.

$$\tilde{\chi}_1^+ \to e^+ + \tilde{\nu}_e, \quad \chi_1^0: \to \nu\tilde{\nu},$$

M2=mu maximizes diphoton decay.

- LSP and NLSP are lighter than 100GeV!

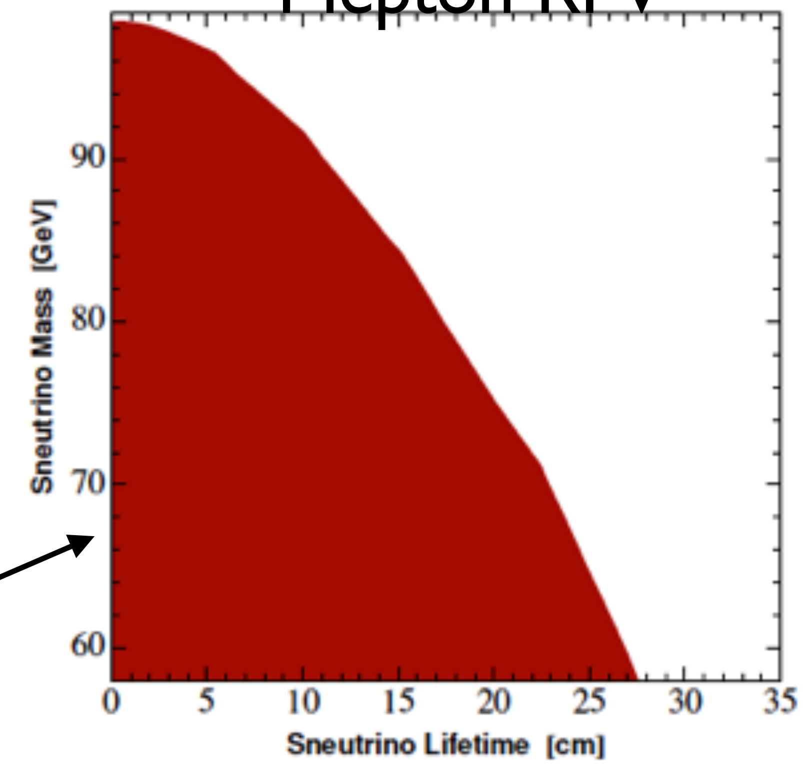
- Strongest constraints are from LSP pair and NLSP pair productions at LEP. (NB: LHC looks for the heavy)

LEP constraints

$\tilde{\nu}_e \to e^- + \mu^+$

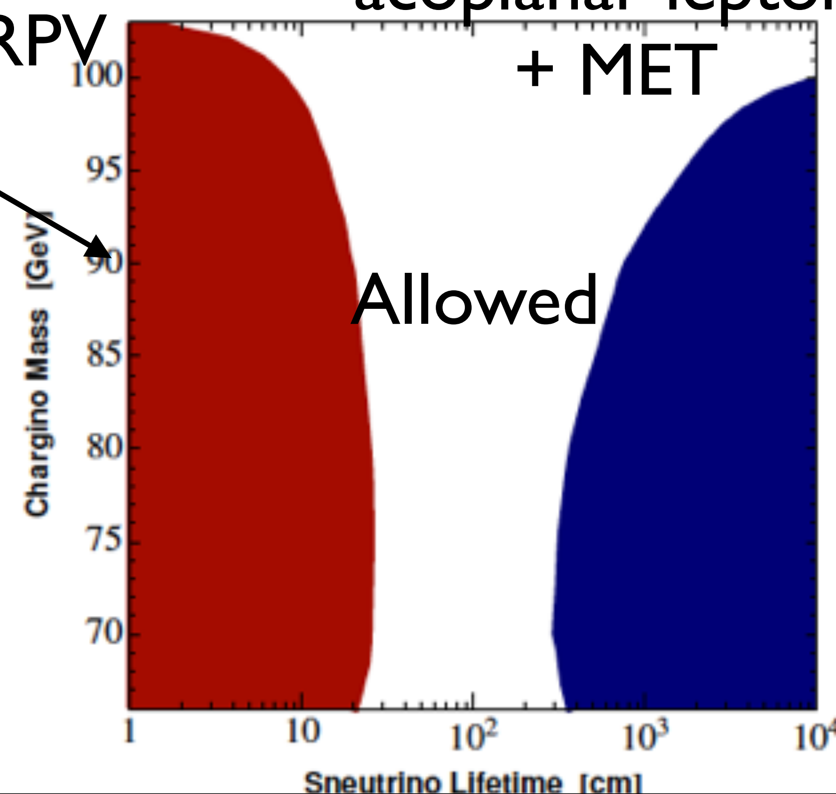
$\tilde{\chi}_1^+ \to e^+ + \tilde{\nu}_e$

4-lepton RPV



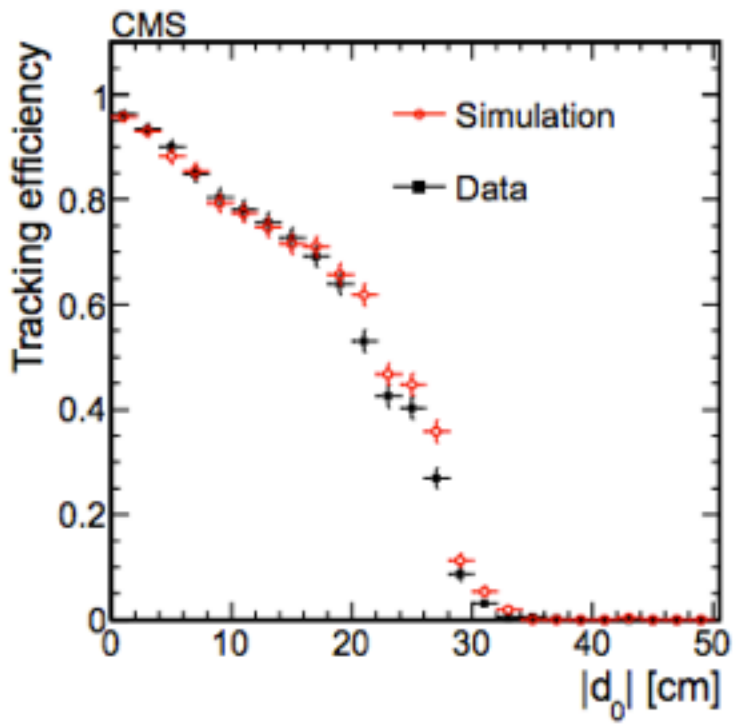
Too much prompt decays excluded.

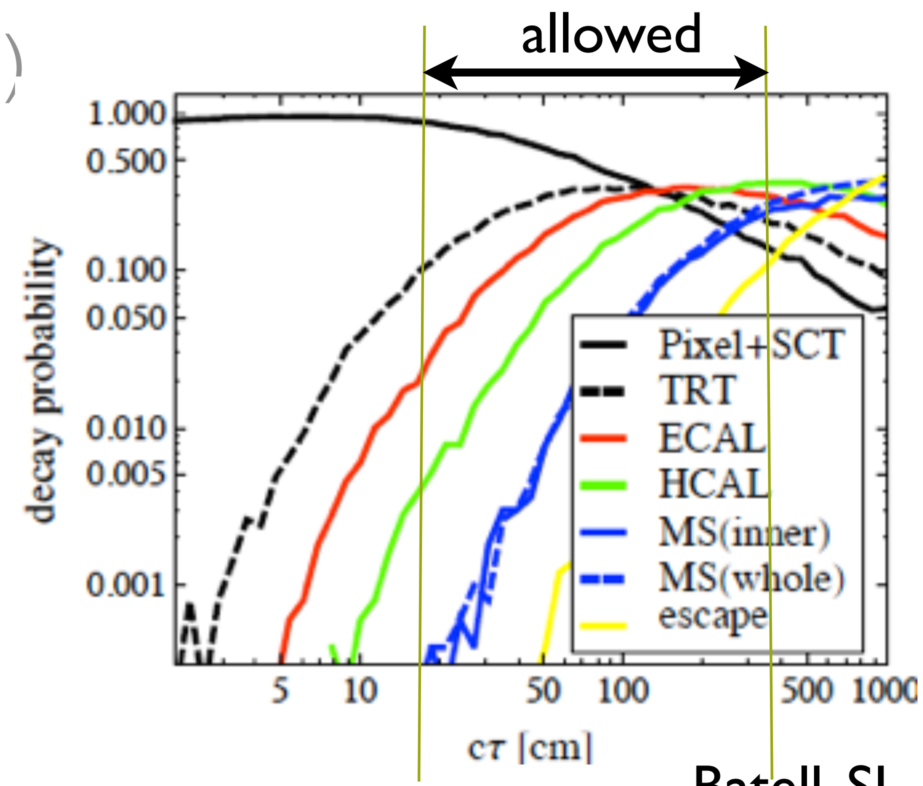
Too much decay outside detector.



Pink elephant signatures

- 1) Characteristic signature is “displaced e +mu resonance”.
- a) trackless narrow jets + large HCAL/ECAL energy ratio or muon stuck inside.
- b) Full 4-mon recon of disp. vert. (D.Shih et al)
- ATLAS/CMS have been developing these triggers.





Batell, SJ, Wagner

Summary

- Studied what it takes to discover gluinos in split SUSY, and re-expressed in terms of gluino-to-LSP mass ratio. Applied to AMSB, GMSB and mirage.
- Split SUSY NLO corrections to gaugino are not negligible.
- Developed new variables exploiting compressed decay kinematics that can improve searches.
- A possibility of very light charginos based on displaced decay is discussed. Search techniques are developing.