pMSSM scan!

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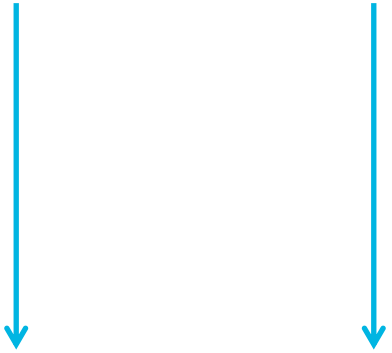
Summary of the scan

	With Δa_μ	Without Δa_μ	Total
Sampled points	14,194,316	4,531,457	18,725,773
McMC accepted points	220,241	2,619,899	2,840,140
Post-process accepted points	57,837	1,110,098	1,167,935
Total Efficiency	0.41%	24.5%	6.24%
Squark, gluino masses > 10 TeV	7,484	200,376	207,860
Δm(LSP, gluino) < 500 GeV	90	2,735	2,825
Δm(LSP, stop) < 500 GeV	79	2,174	2, 253
Δa_μ within measured $\pm 1\sigma$ of	23,483	918	4,401



15 lingering PP jobs will still add a TINY bit of statistics here

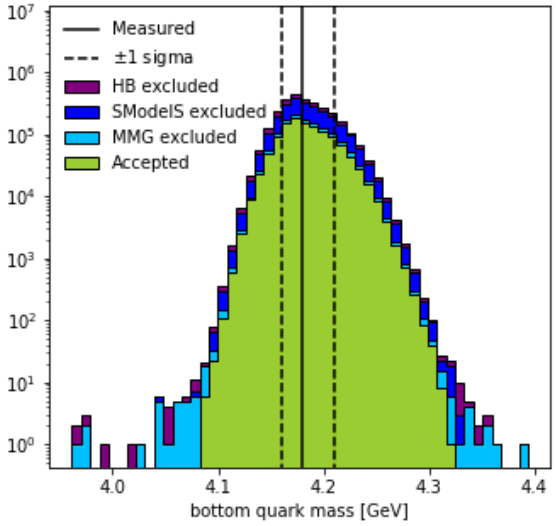
Beyond the McMC: further excluded points

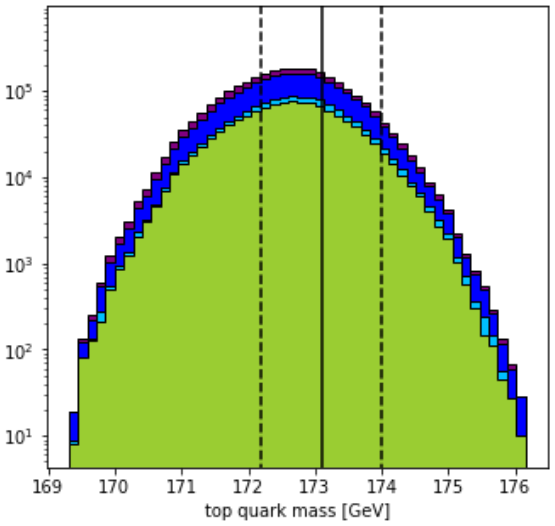
- **Purple**: excluded at 95% CL by HiggsBounds (HB)
  - Heavy Higgs to tau tau search
- **Royal blue**: allowed by HB, excluded at 95% CL by SModelS
  - LHC SUSY searches (Run 1 and 2)
- **Sky blue**: allowed by HB and SmodelS, excluded at 95% by MicrOMEGAs
  - Including Z → invisible, LEP DM searches, DM mass limits, direct detection experiments
- **Green**: accepted by all

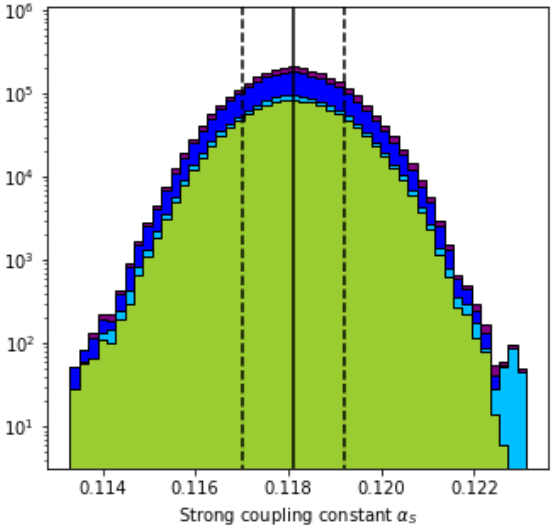
SM observables

Directly included
in McMC likelihood

- McMC likelihood steers these observables to peak near the measured values







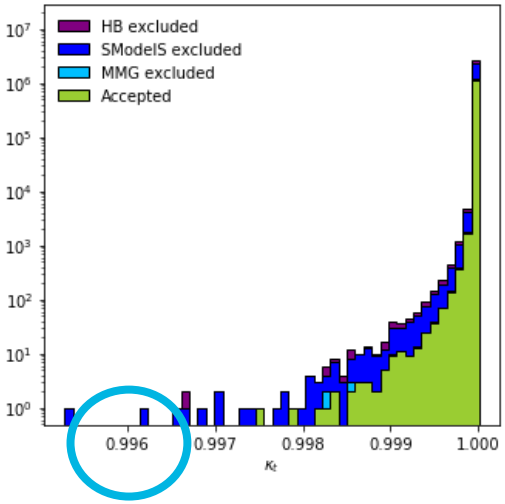
Fermilab

Higgs boson couplings

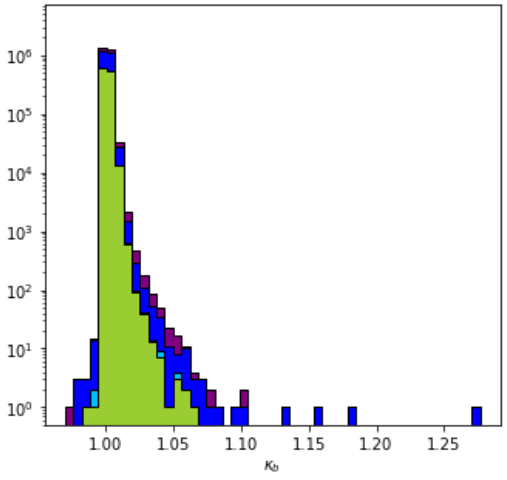
Indirectly included in McMC likelihood

- Calculated Higgs couplings to top, bottom, charm, τ, μ, W, Z for each pMSSM point
  - Pseudo-scalar component for fermion couplings always ~ 0
  - κ_t, κ_c, κ_W and κ_Z peak so close to SM that future precision unlikely to yield separation power

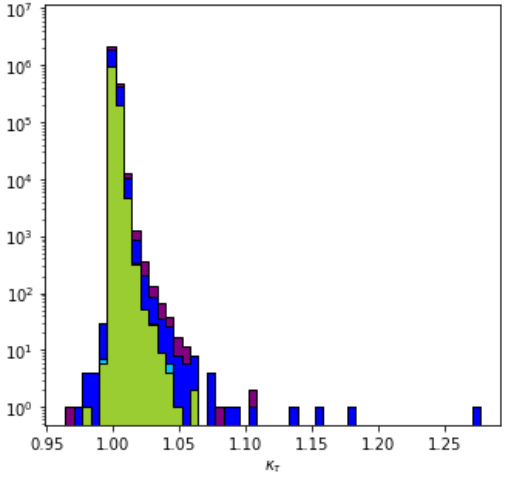
Top ~ charm



Bottom



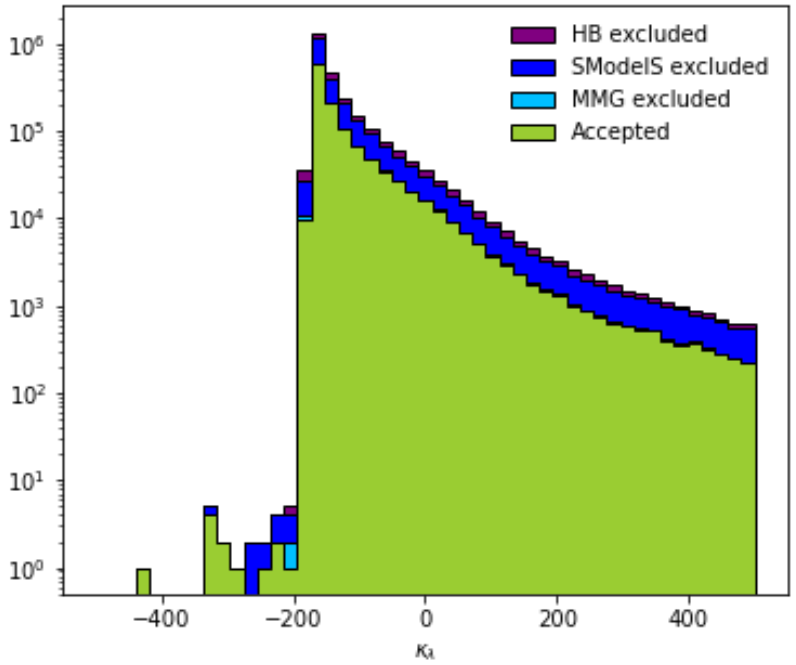
Tau ~ μ



Fermilab

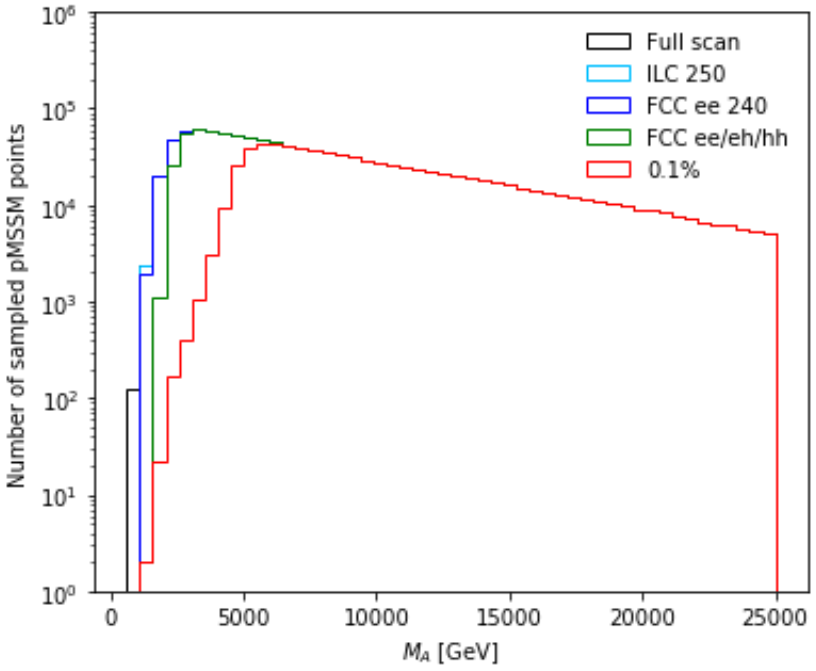
Self coupling

- Not normalized, have tried a few reasonable norms with no success
  - $m_H^2 / 2v^2$, $m_H^2/2v$
- Why does it go below zero?



Future precision on κ_b

- Increasing prevision on κ_b measurement (with central value remaining SM) eliminates models containing a light heavy Higgs boson M_A
  - Similar effect for κ_τ and κ_μ

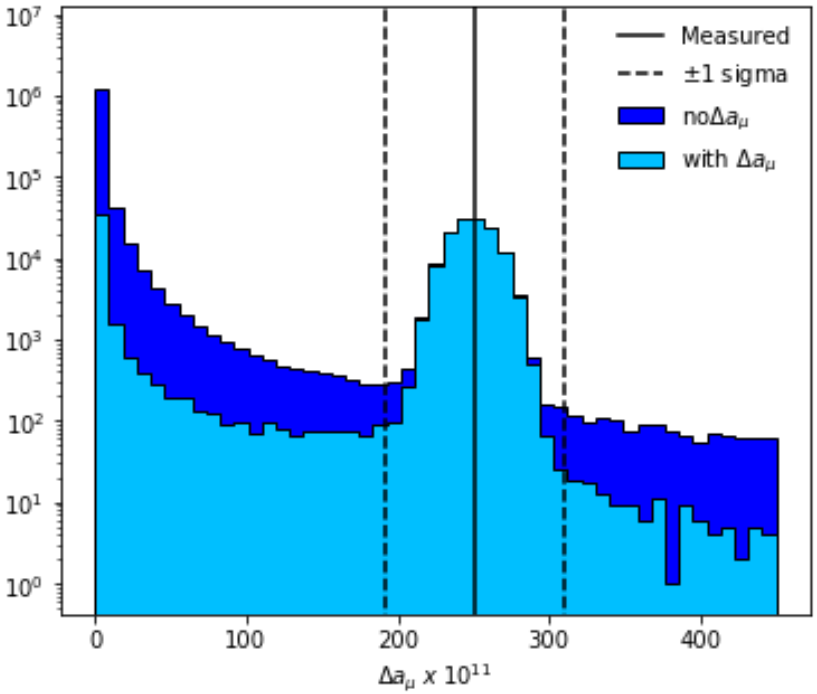


Precision from [1905.03764](1905.03764)
ILC 250: 1.8%
FCC-ee 240: 1.3%
FCC-ee/eh/hh: 0.43%

Pie in the sky: 0.1%

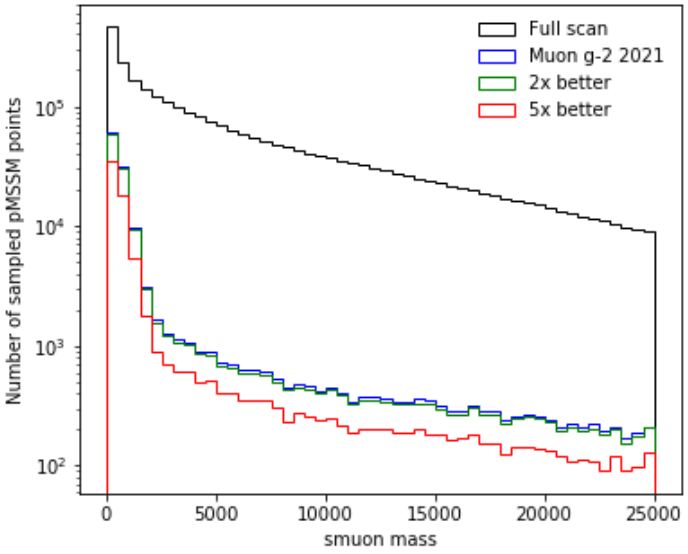
Anomalous muon magnetic moment

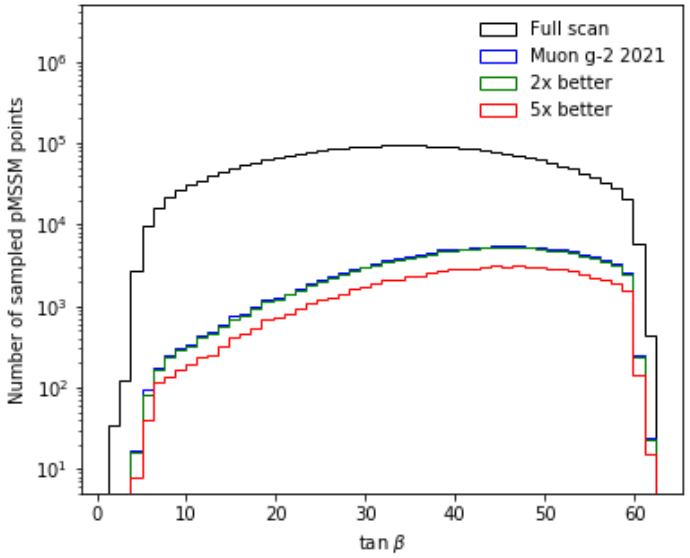
- Want our scan to populate both the measured value of Δa_μ = 251 x 10^{-11} and the SM value of Δa_μ = 0
  - Half of scan threads include a Gaussian contribution from Δa_μ centered at 251 x 10^{-11}



Future precision on Δa_μ

- Increasing precision around the measured central value of $\Delta a_\mu = 251 \times 10^{-11}$ constrains
  - Smuons to light masses
  - Tanβ (ratio of Higgs vevs) to high values

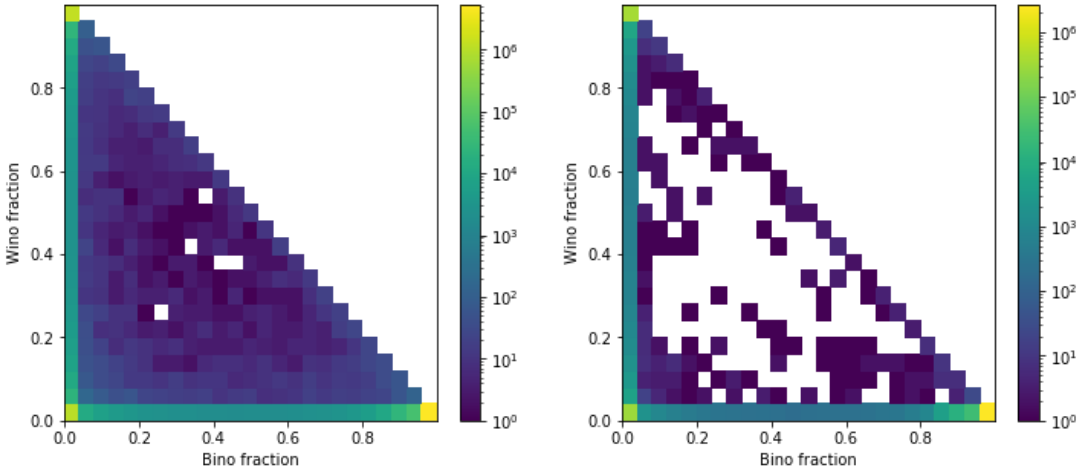




Electroweakino composition of LSP

- Most sampled points have ~pure in EWino composition
  - Mostly : > 80%, Mixed: > 40%/40%

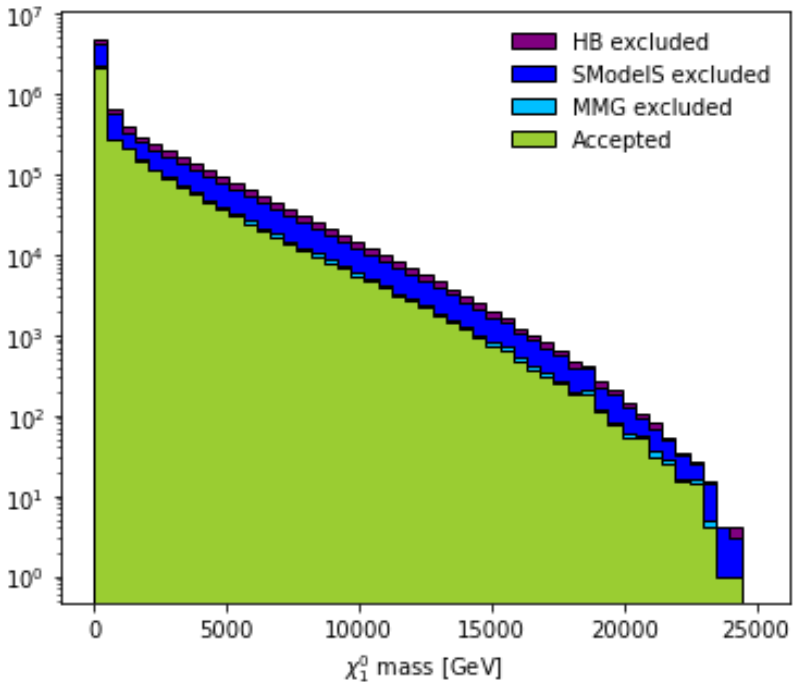
	McMC accepted	Post-process accepted
Mostly wino	488,346	126,376
Mostly bino	1,902,877	930,519
Mostly higgsino	411,475	106,183
Mixed wino/bino	37	6
Mixed bino/higgsino	6,578	991
Mixed wino/higgsino	3,477	341
Other	27,350	3,519

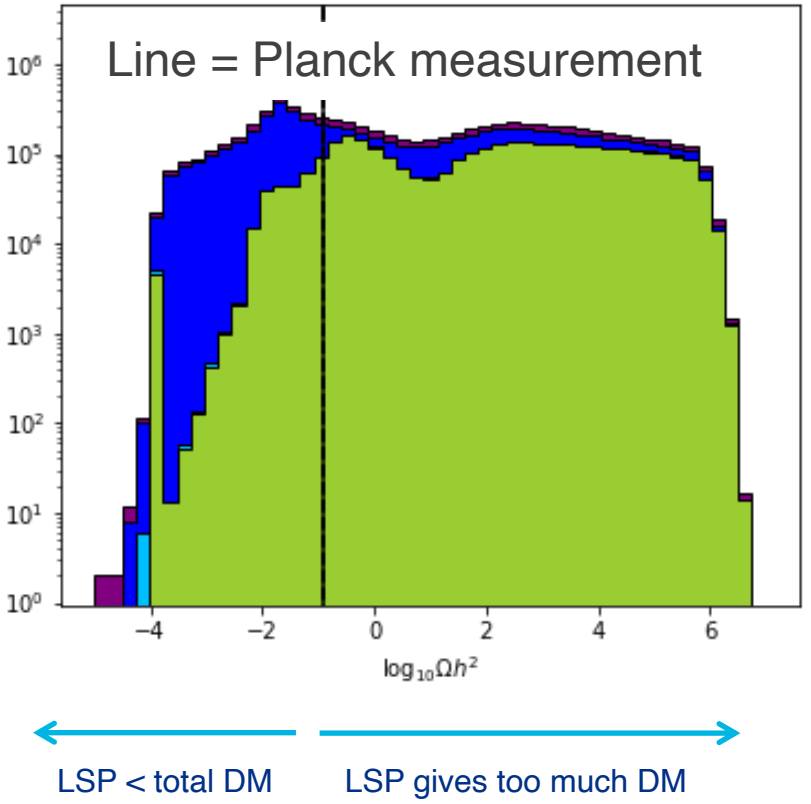


Fermilab

DM mass, relic density

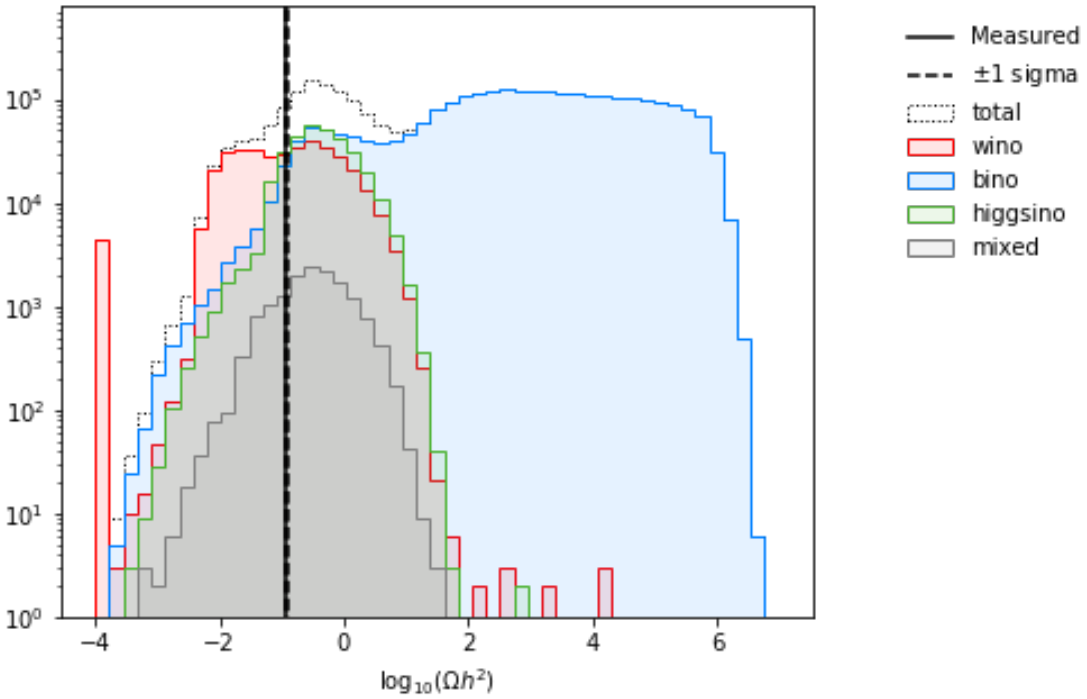
- LHC searches exclude points with low relic density
  - Mostly corresponds to wino-like DM





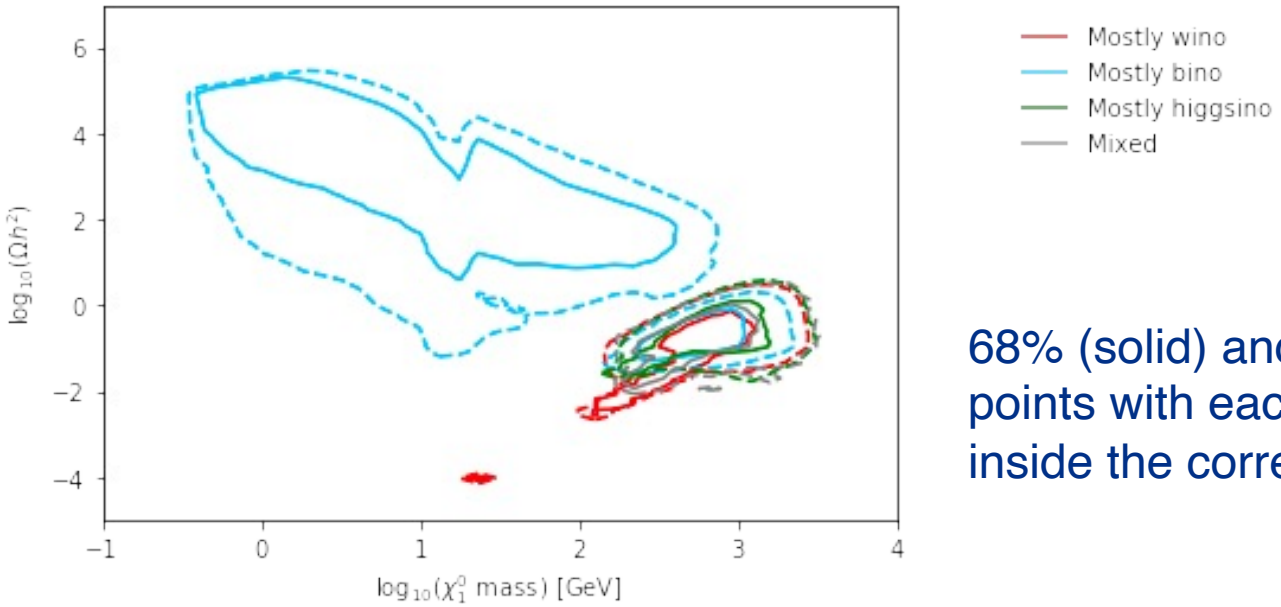
DM relic density per EWino state

- Wino-like LSP tends to have lower relic density, bino-like tends to have high
- Higgsino-like, mixed in the middle



LSP mass vs relic density

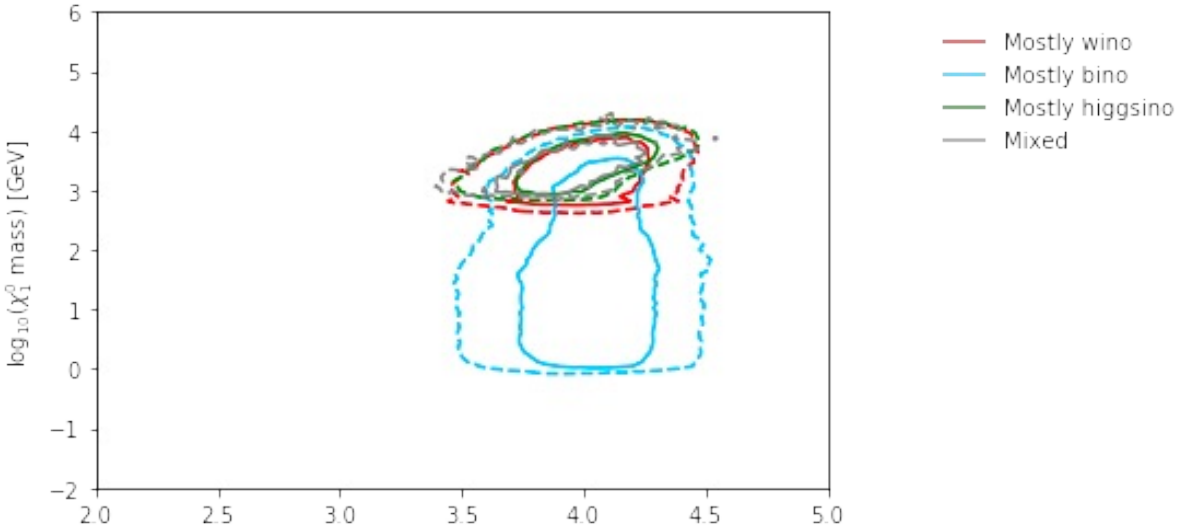
- Bino-like DM allowed to have light mass (artifact of ranges)
  - Too high relic density: requires co-annihilation
- Other EWino states ~roughly~ in agreement with measured relic density of 0.120 (±0.001)



68% (solid) and 95% (solid) of points with each composition are inside the corresponding contour

LSP mass vs. stop mass

- For bino-like DM, stop mass tends to be a bit heavier



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