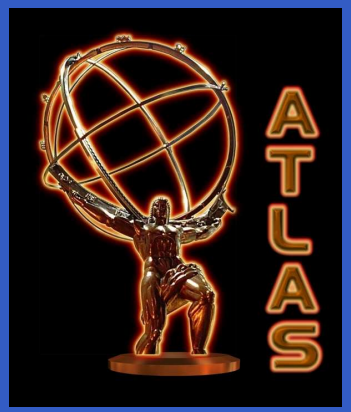
Ideal Higgs Scenario [a] After the h_{125} Measurements



Chris Potter

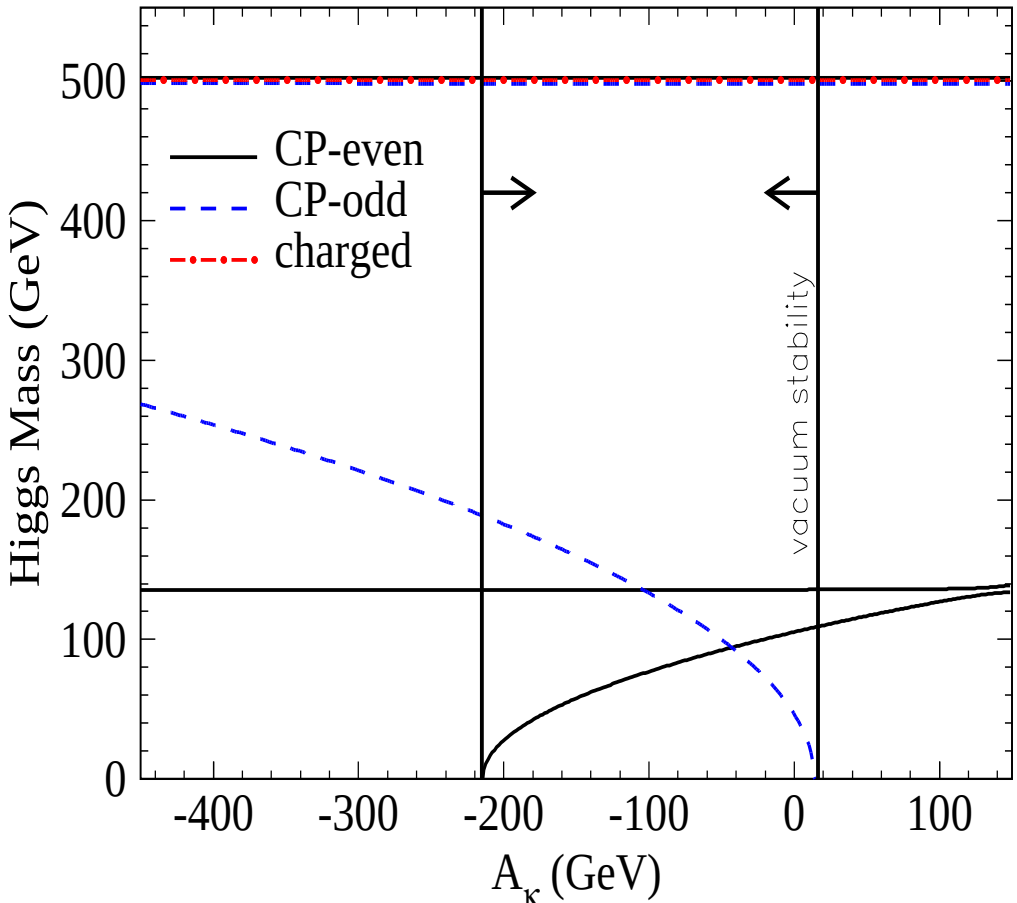
University of Oregon

[a] Phys.Rev.Lett.95:041801,2005; Phys.Rev.D75:075019,2007; Phys.Rev.D79:055014,2009; etc.

NMSSM Higgs Mass Spectrum

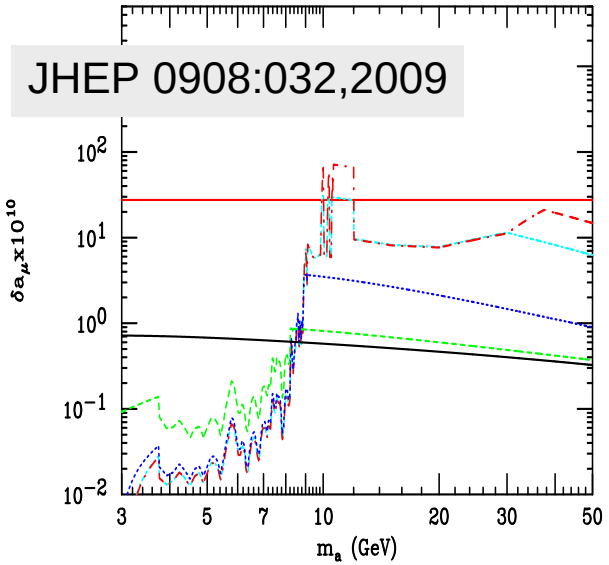
Low mass scalars a_1 and h_1 absent in the MSSM but present in the NMSSM are motivated by the anomalous muon magnetic moment and the LEP excess in the $Zh \to Zb\bar{b}$ channel.

Nucl.Phys.B681:3-30,2004

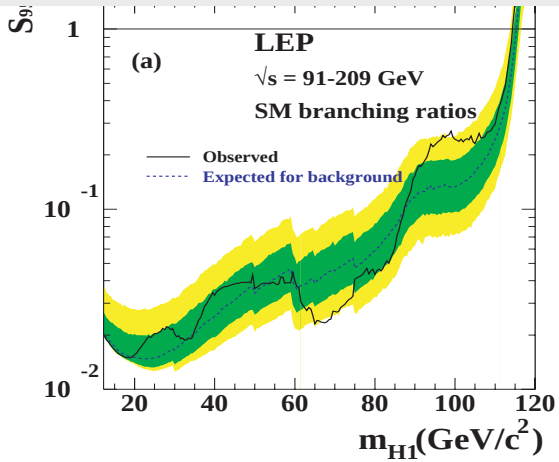


$\lambda = 0.3, \kappa = 0.1, v_s = 3v, \tan\beta = 3, m_A = \mu \tan\beta \approx 470$ GeV

JHEP 0908:032,2009

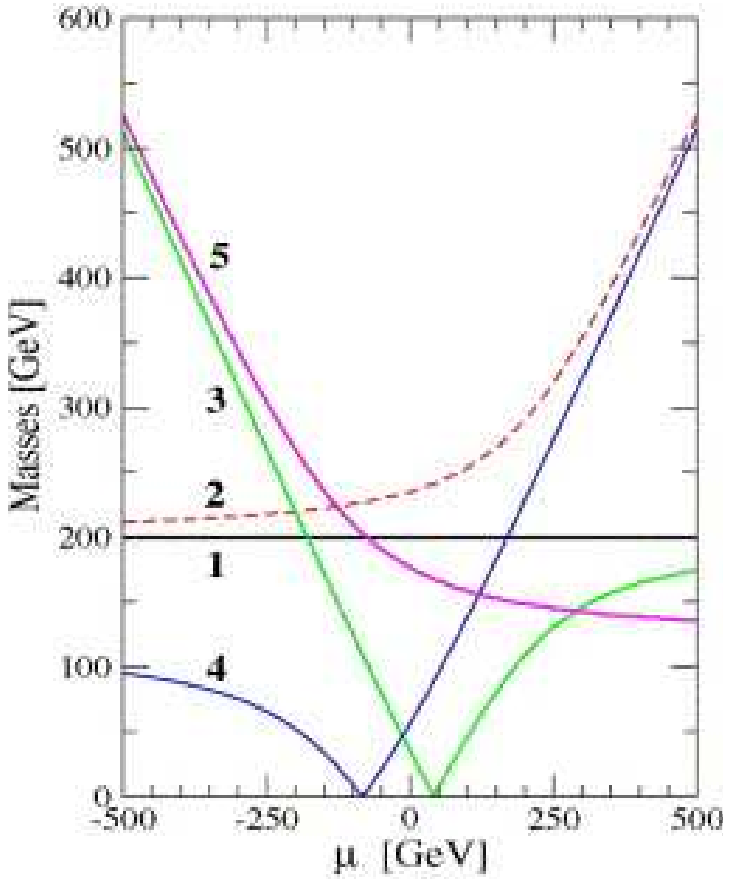


Eur.Phys.J.C47:547-587,2006



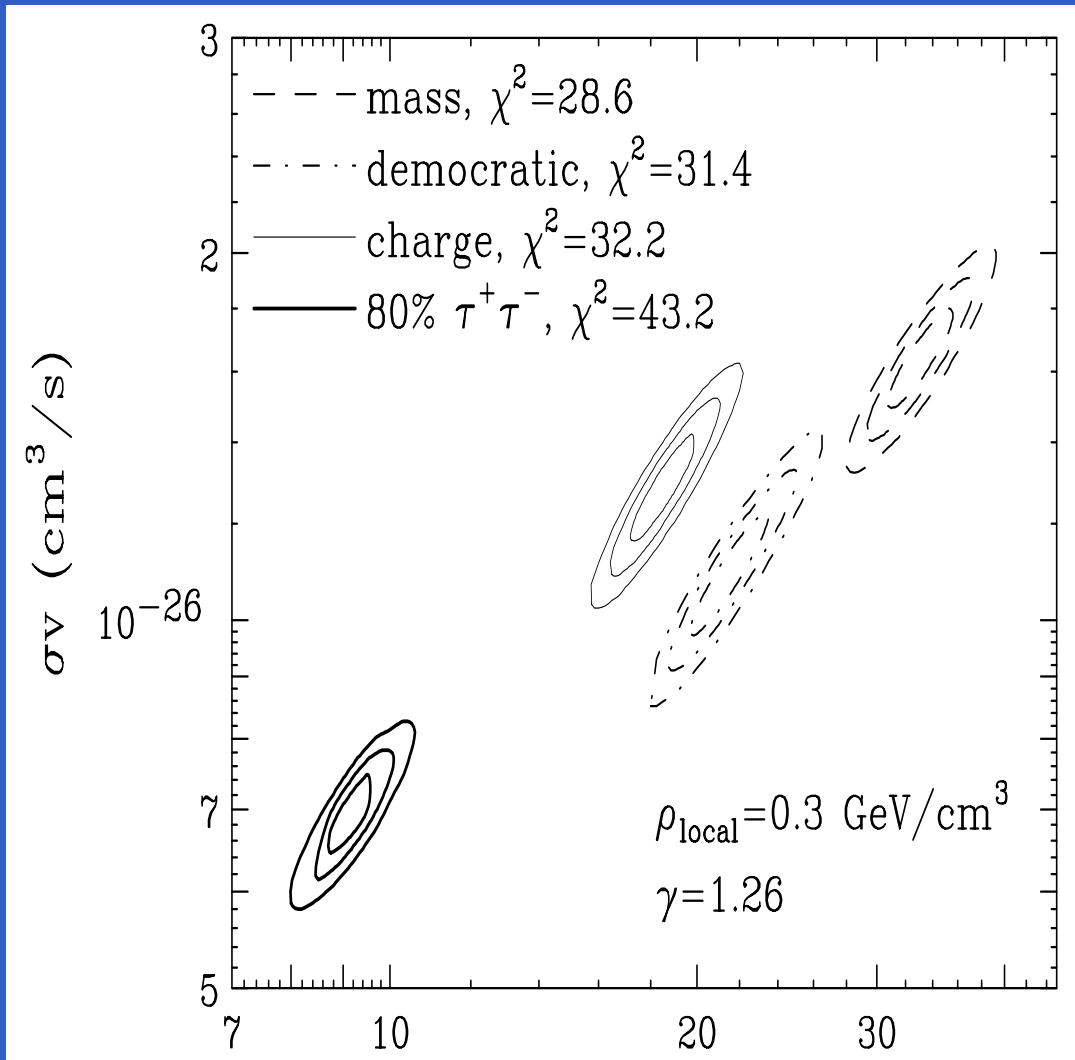
NMSSM Neutralino Mass Spectrum

Low mass neutralinos χ absent in the MSSM are motivated by the gamma ray excess in the galactic core and the dark matter relic density as low mass scalars allow $\chi\chi \to a_1, h_1 \to q\bar{q}, \ell^+\ell^-$.



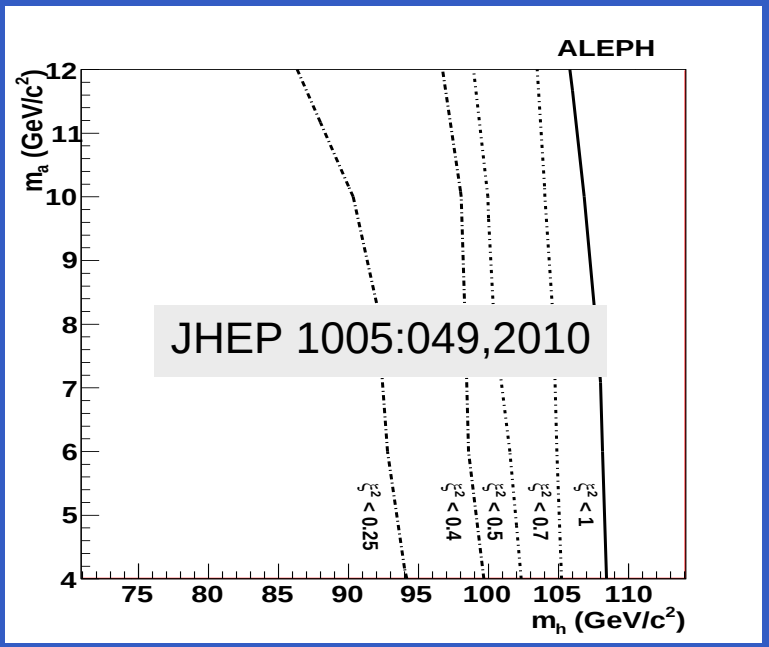
$m_1 = m_2 = 200$ GeV, $\mu_\kappa = 120$ GeV, $\mu_\lambda = 100$ GeV

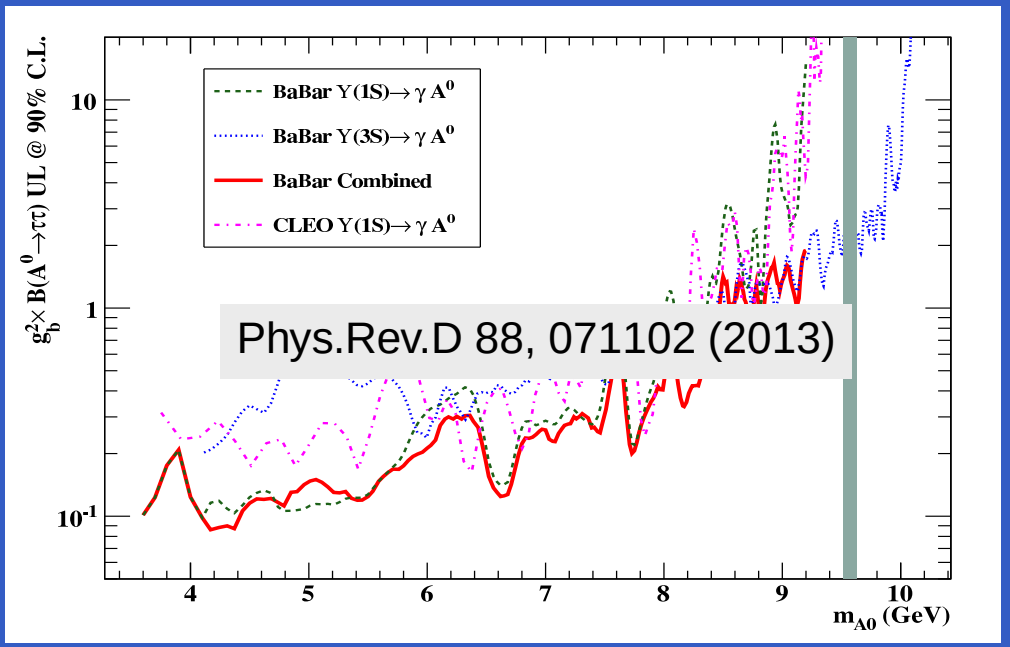
Nucl.Phys.B711:83-111,2005

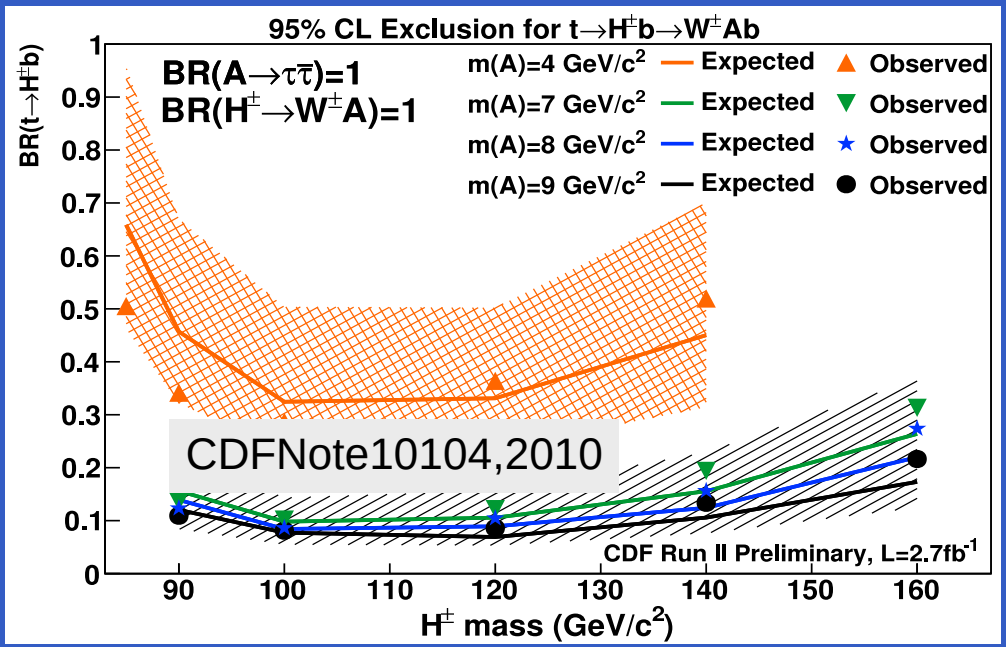


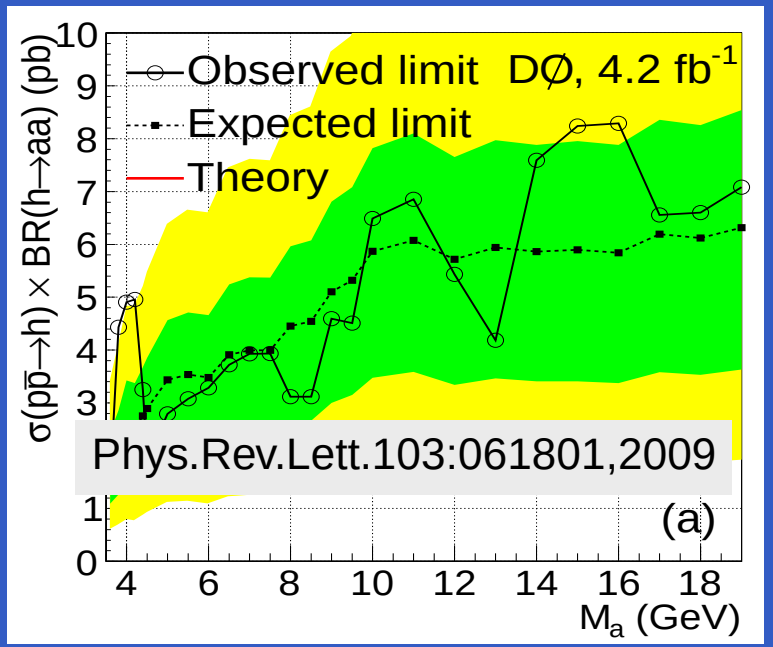
arXiv:1402.6703

NMSSM Ideal Higgs at Aleph,BaBar,DZero,CDF

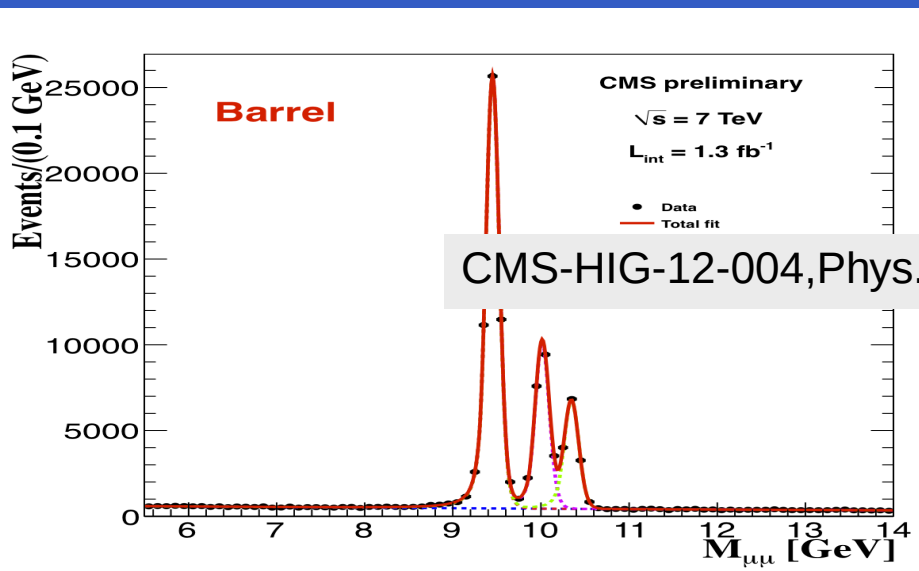




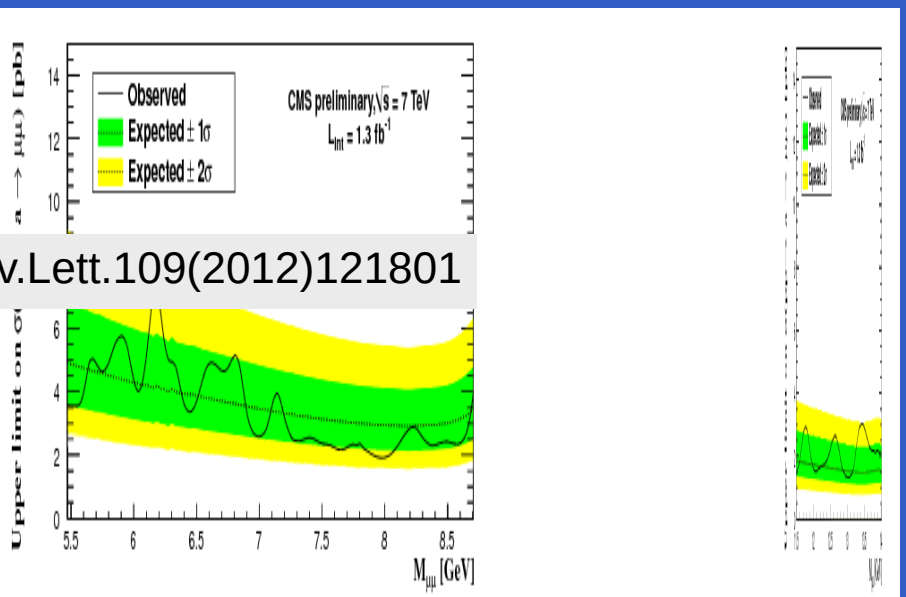


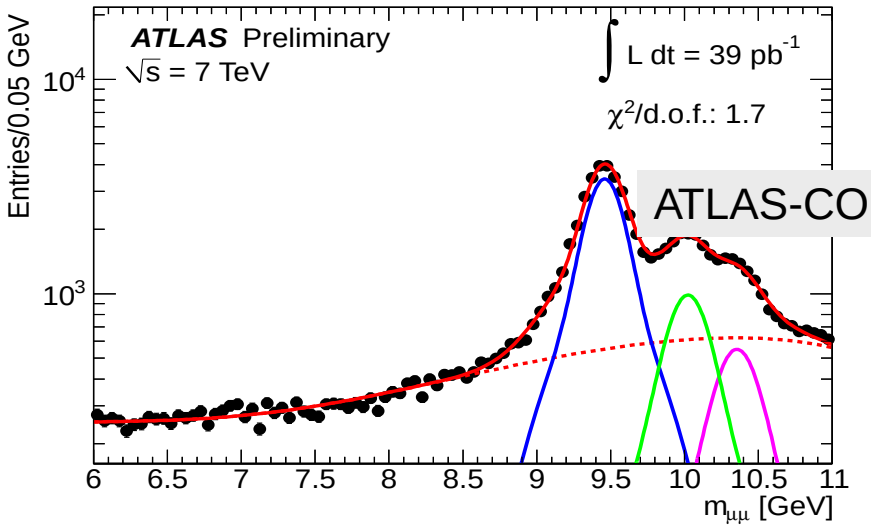


NMSSM Ideal $gg \rightarrow a_1 \rightarrow \mu^+\mu^-$ at CMS,ATLAS

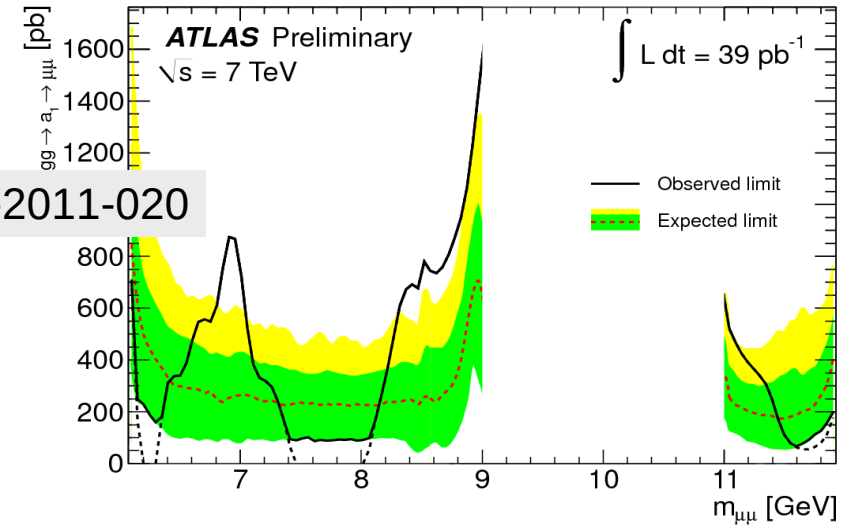


CMS-HIG-12-004,Phys.Rev.Lett.109(2012)121801





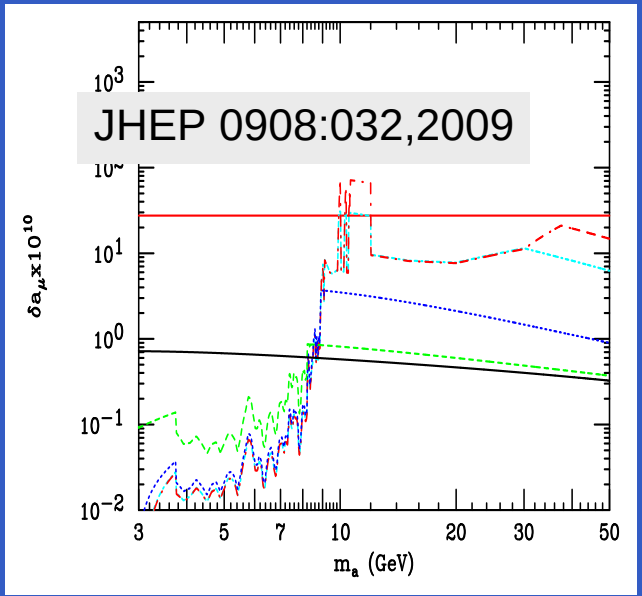
ATLAS-CONF-2011-020

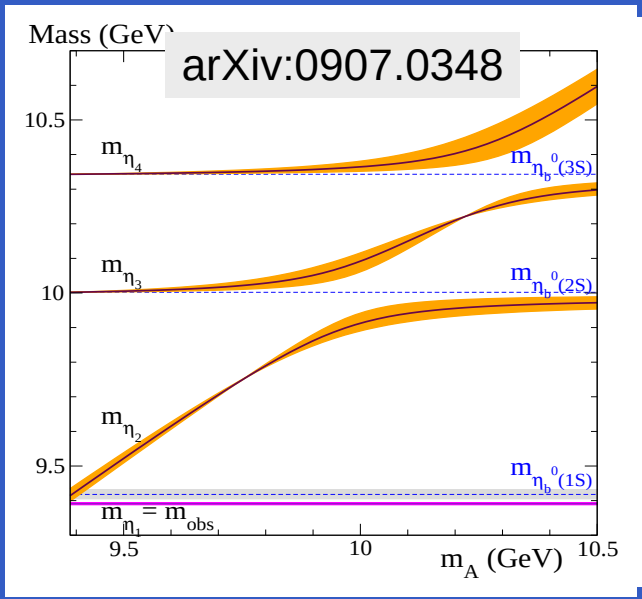


At left, muon pair mass. At right, limits on $\sigma \times BR$ obtained with CLs technique.

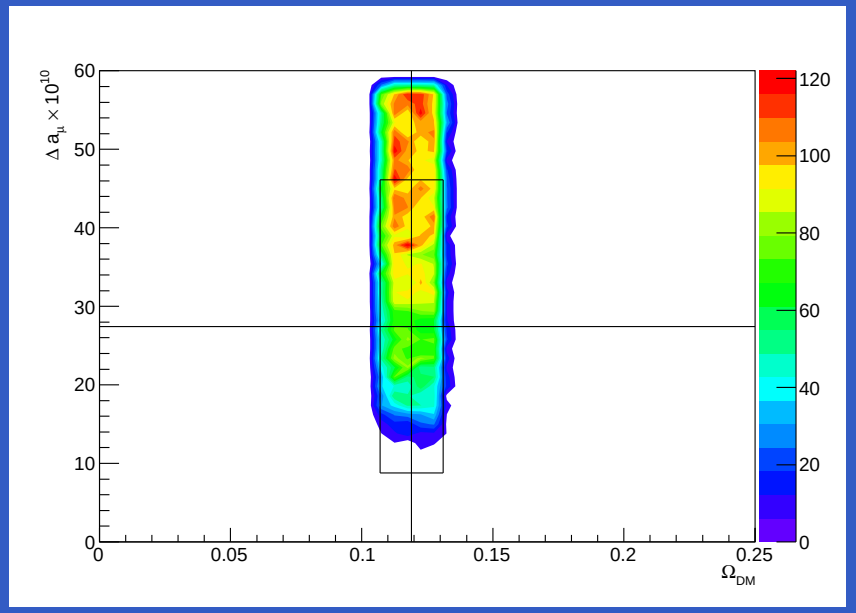
NMSSMTools4.4.0 Random Scan of 10^9 Points

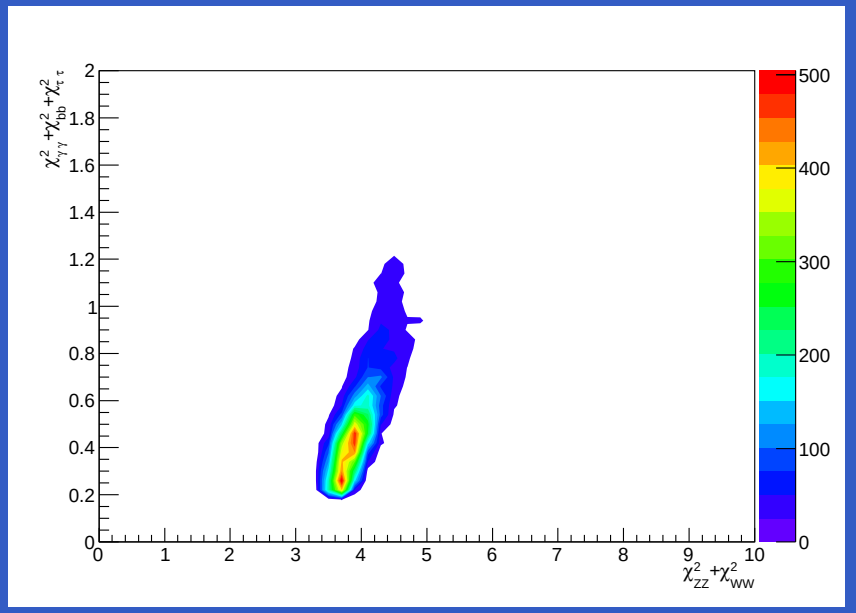
- Scan Parameter Ranges
  - $1 < \tan\beta < 30$ and $100 < \mu < 200$ GeV
  - $0 < |\kappa| < 0.01$ and $0 < \lambda < 0.02$
  - $100 < M_2 < 400$ GeV, unif. constraints M_1, M_3
  - $250 < M_{Q3} = M_{U3} < 1500$ GeV
  - $0.8 < X_t/X_0^{max} < 1.8$, X_0^{max} is tree-level max. mix.
  - $300 < m_A < 3000$ GeV and $9.9 < m_P < 10.5$ GeV
- Constraints Imposed During Scan (10.9M points survive)
  - Dark Matter Relic Density Ω_{DM}
  - Anomalous Muon Magnetic Moment Δa_μ
  - All Collider Constraints
  - $123 < m_{h_1} < 127$ GeV or $123 < m_{h_2} < 127$ GeV
  - Higgs signal strength μ $\chi^2_{ZZWW}, \chi^2_{bb\tau\tau}, \chi^2_{\gamma\gamma} < 6$
- Constraints Imposed After Scan
  - $124.73 < m_{h_2} < 125.33$ GeV (CMS-PAS-HIG-14-009)
  - Signal strength $\chi^2_{ZZWW} + \chi^2_{bb\tau\tau} + \chi^2_{\gamma\gamma} < 7$

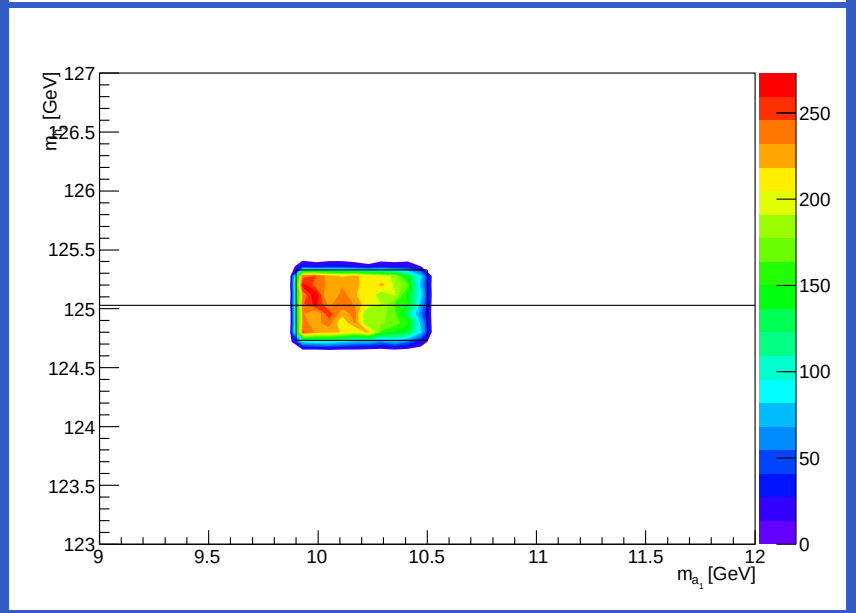


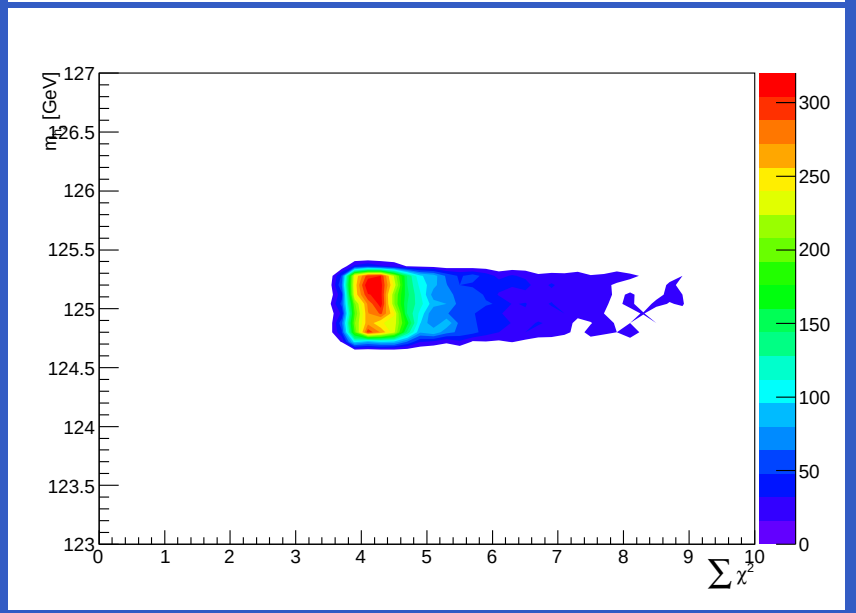


Constraints: Δa_μ, Ω_{DM}, h_{125}



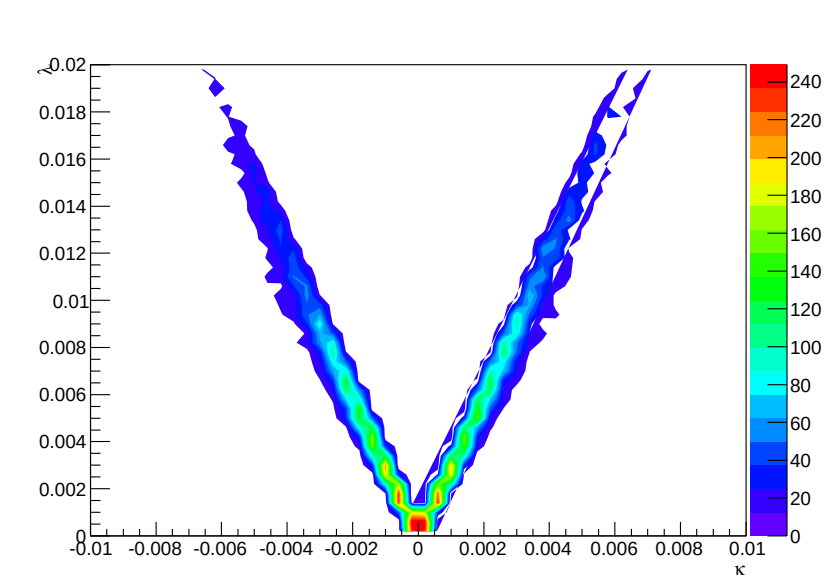


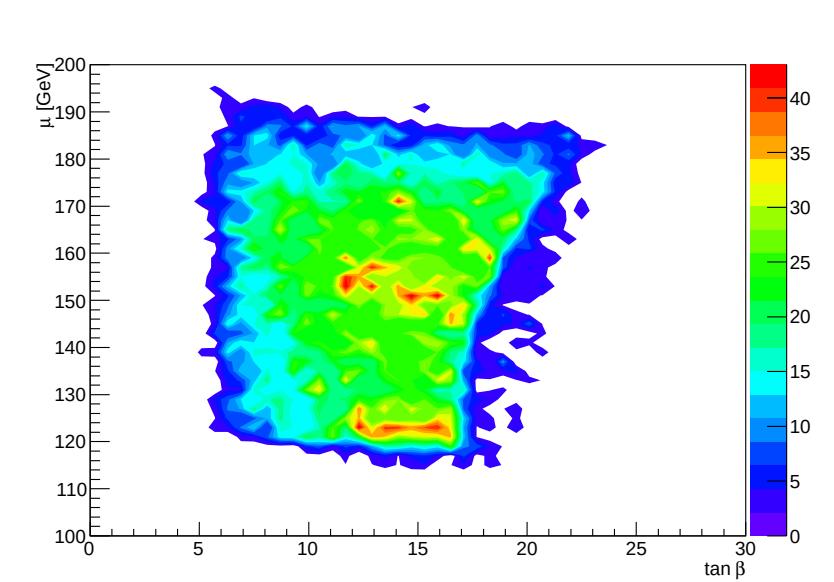


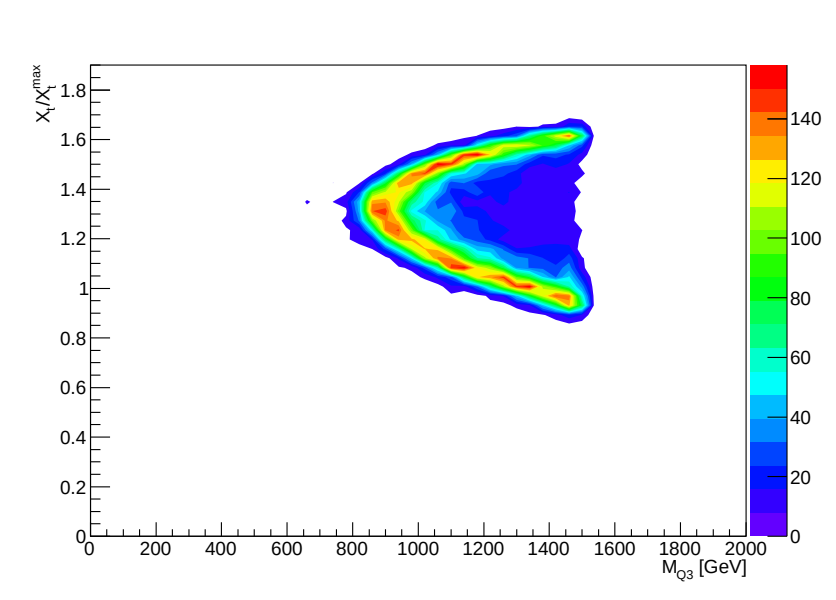


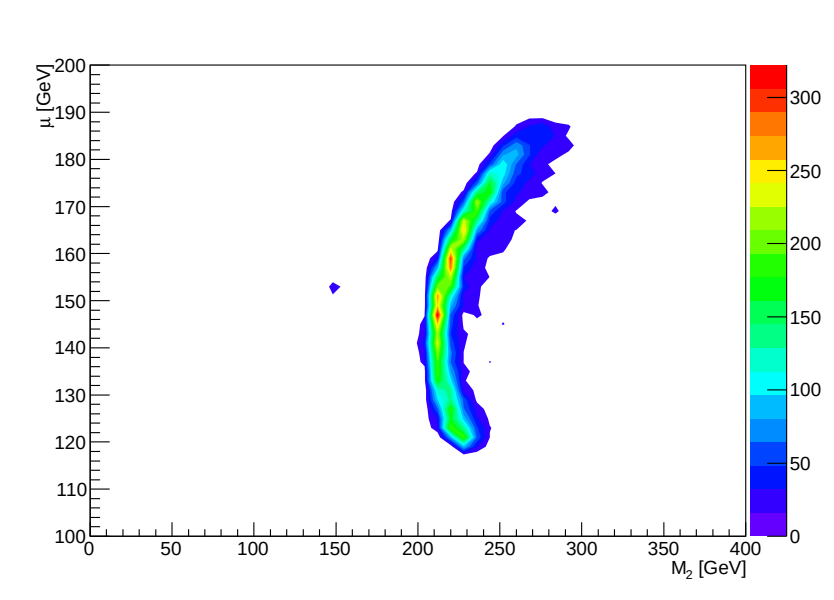
Clockwise from top left, Δa_μ vs Ω_{DM}, $\sum \chi^2_{ff}$ vs $\sum \chi^2_{VV}$, m_{h_2} vs $\sum \chi^2$, m_{h_2} vs m_{a_1}.

Scanned Parameters After Constraints



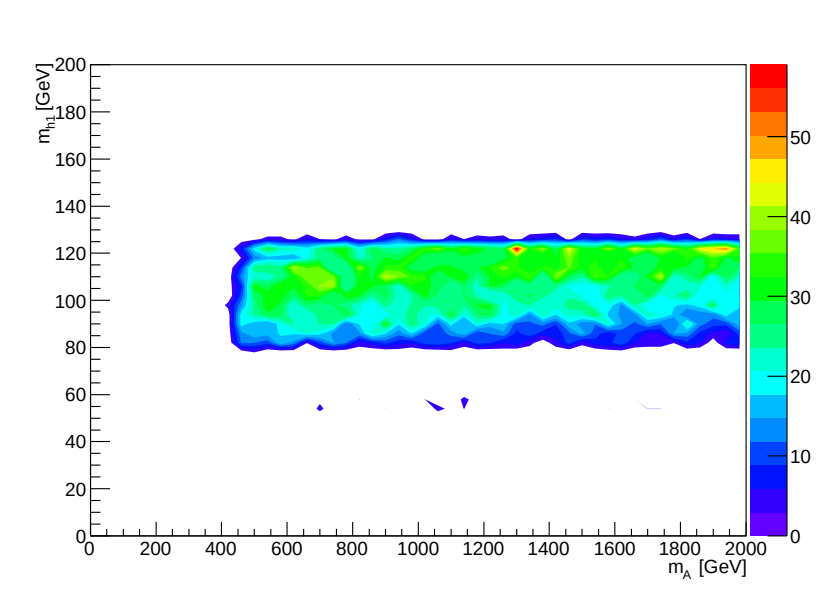


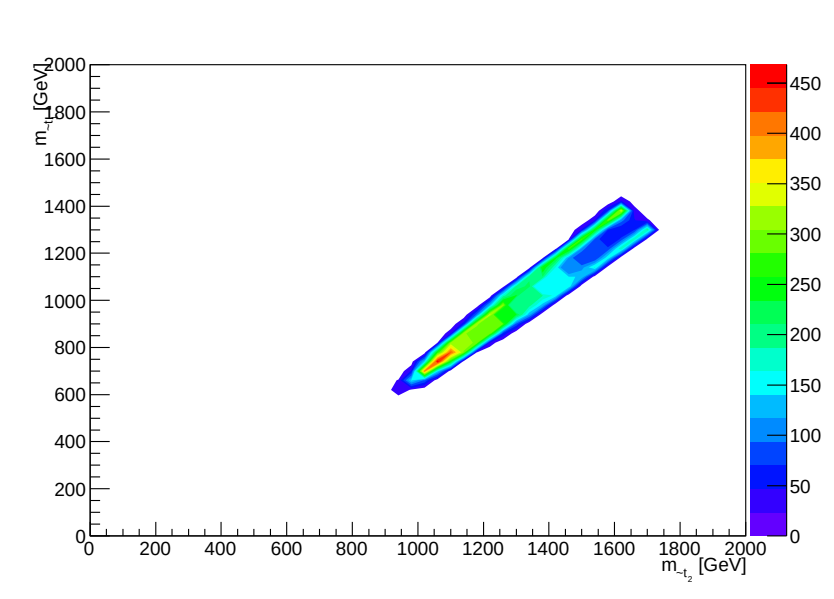


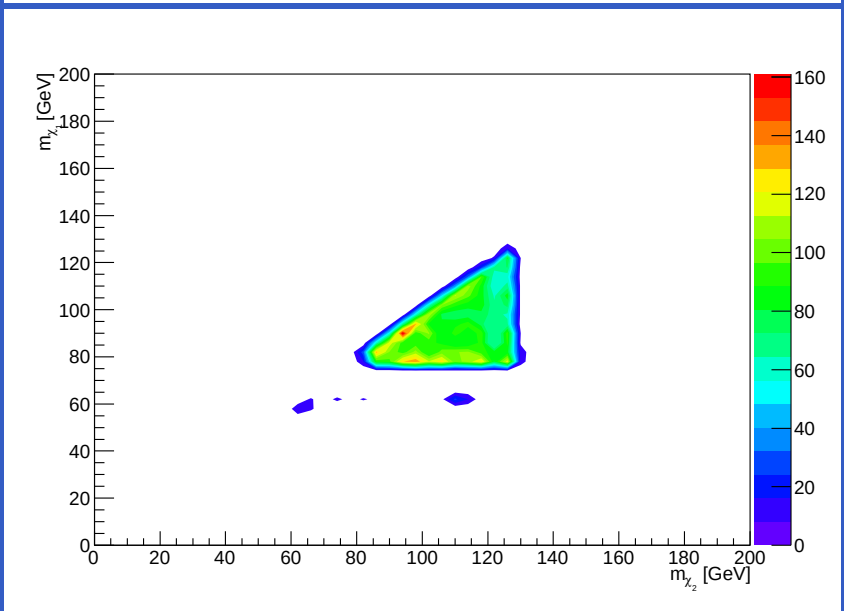


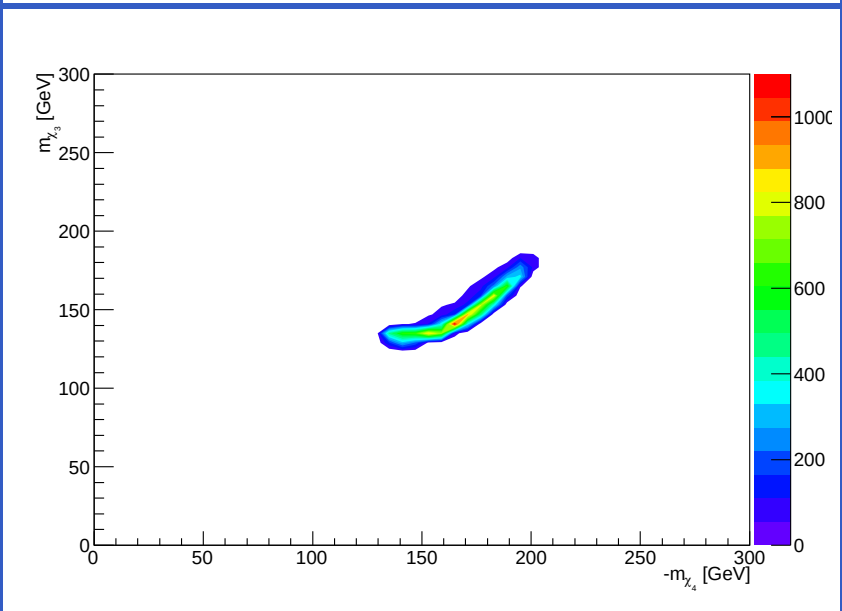
Clockwise from top left, λ vs κ, μ vs $\tan\beta$, μ vs M_2, X_t/X_0^{max} vs M_{Q3}.

Mass Spectra After Constraints



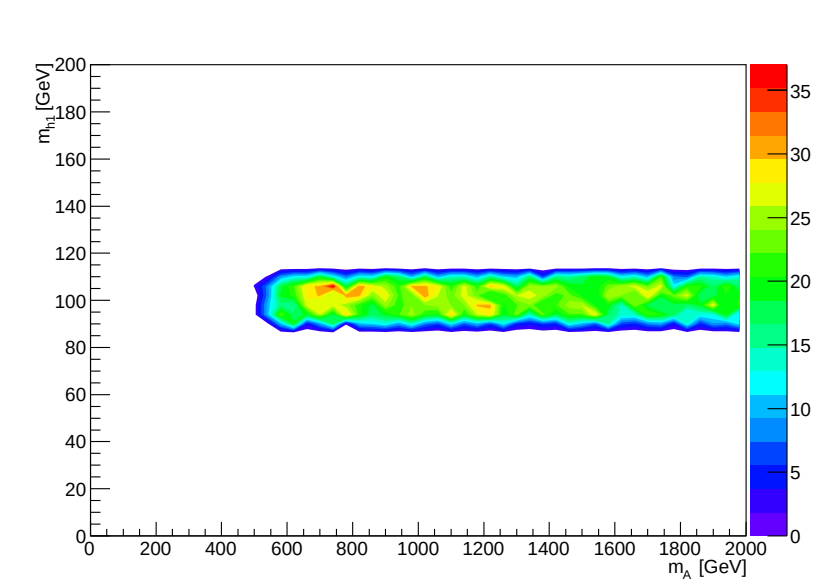


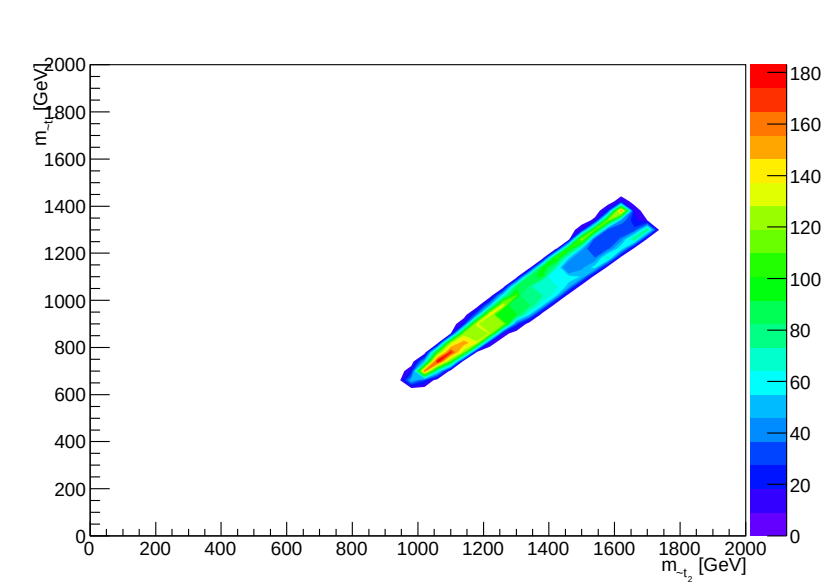


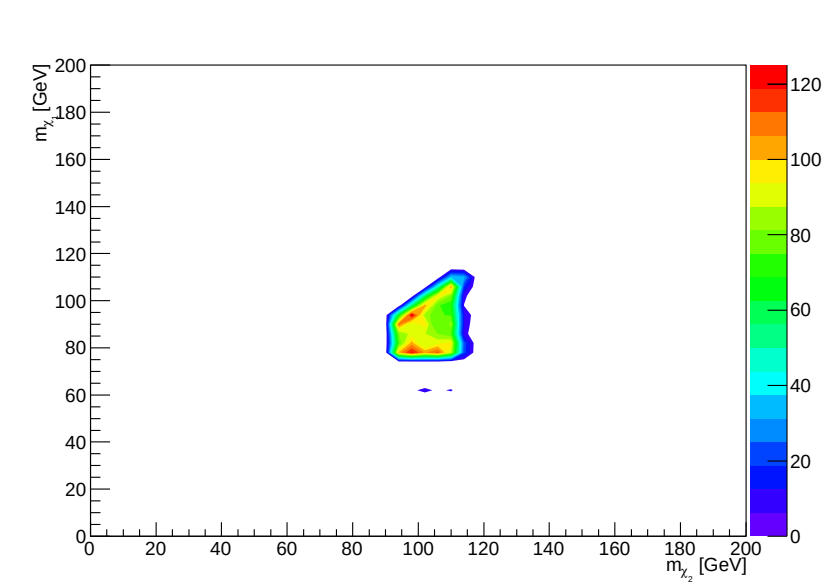


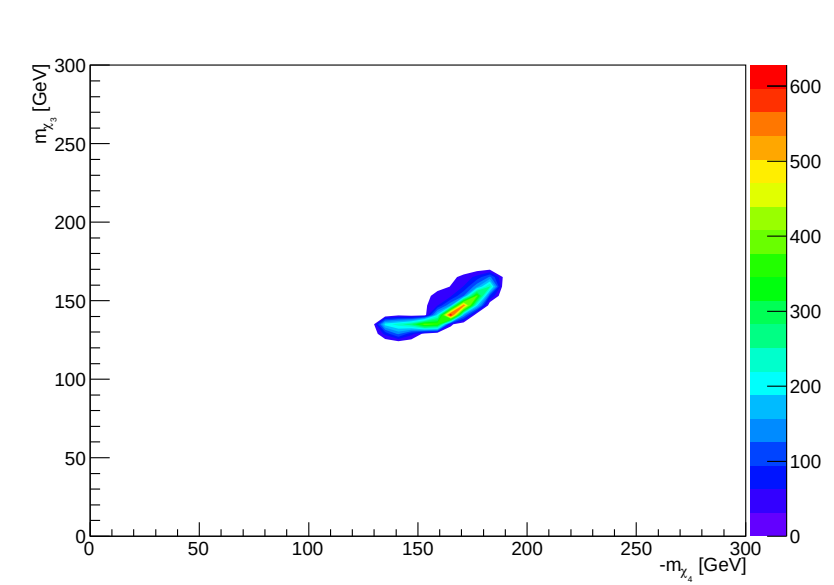
Clockwise from top left, m_{h_1} vs m_A, $m_{\chi 1}$ vs $m_{\chi 2}$, $m_{\chi 3}$ vs $m_{\chi 4}$, $m_{\chi 1}$ vs $m_{\chi 5}$.

Adding Constraint $90 < m_{h_1} < 110$ GeV









Clockwise from top left, m_{h_1} vs m_A, $m_{\chi 1}$ vs $m_{\chi 2}$, $m_{\chi 3}$ vs $m_{\chi 4}$, $m_{\chi 1}$ vs $m_{\chi 5}$.

Conclusions and Questions

Conclusions

- The NMSSM Ideal Higgs scenario, with a low mass a_1 $9.9 < m_{a_1} < 10.5$ GeV , is still viable after imposing the Higgs mass and signal strength constraints if the h_{125} is the h_2.
- Surviving points prefer small κ and λ, moderate $\tan\beta$, large stop mixing, $120 < \mu < 190$ GeV and $200 < M_2 < 250$ GeV.
- If the constraint $90 < m_{h_1} < 110$ GeV is applied, motivated by the LEP2 Zbb excess, the model becomes highly predictive, with $80 < m_{\chi^0_{1234}} < 170$ GeV and $m_{\tilde{t}} > 600$ GeV.

Open Questions

- How restrictive are the NMSSMTools collider constraints on the stop and neutralino masses?
- The model does not predict neutralinos with mass below $m_\chi \approx 100$ GeV. Is micrOMEGA vetoing these? What about multi-component dark matter?
- How does this work fit in the context of the LHC BSMH WG?
- Any feedback is appreciated.