Early search for SUSY at LHC via multi-muon plus jets events but without ETMISS

- ETMISS requires complete detector knowledge: hot cells, dead cells, mis-measurement, cracks, alignment, cosmics, beam-gas, multiple scatters,...
- ETMISS as a viable cut variable may have to wait for later LHC runs
- Is it possible to search for SUSY without using ETMISS?

Multi-muon plus jets events:

HB, A. Lessa and H. Summy, PLB674 (2009) 49 and
HB, V. Barger, A. Lessa and X. Tata, arXiv:0907.1922

- Reliable e ID may also be problematic early on
- Muon ID should be quite reliable: Atlas, CMS already measuring lots of muons in cosmic ray events
- Sparticle production and cascade decays could be prolific source of multi-muon plus jets events at LHC
- Numerous SM sources of multi-muon plus jets events as well

Some SM background processes

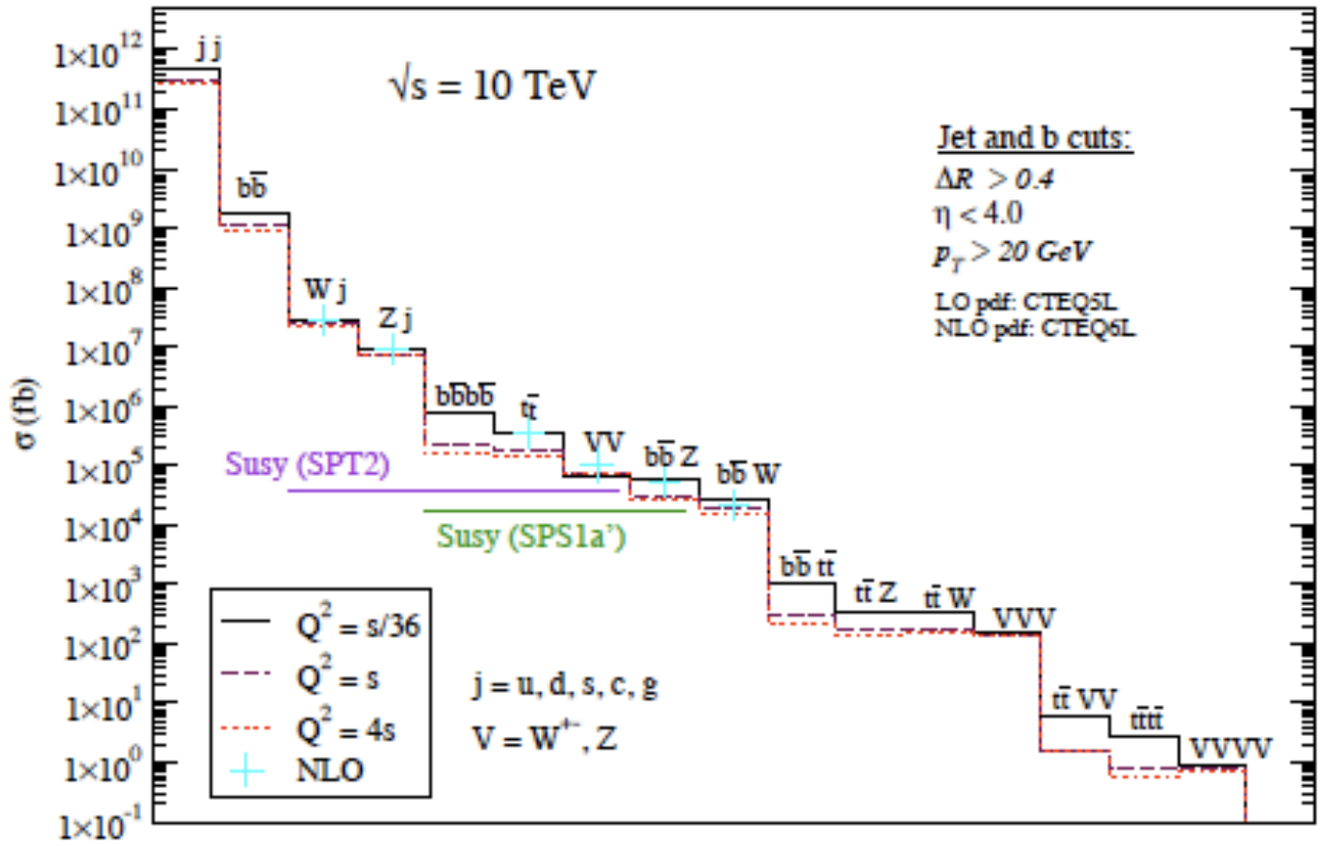

Figure 1: Total cross-sections for several SM backgrounds for pp collisions at $\sqrt{s} = 10$ TeV, with three different choices of renormalization and factorization scales (Q) (taken to be equal) shown by the solid ($Q = \sqrt{\hat{s}}/6$), dashed ($Q = \sqrt{\hat{s}}$) and dotted ($Q = 2\sqrt{\hat{s}}$) lines. The NLO results are shown as blue crosses. The total cross-section for the SUSY SPS1a′ and SPT2 mSUGRA cases are also shown for comparison purposes.

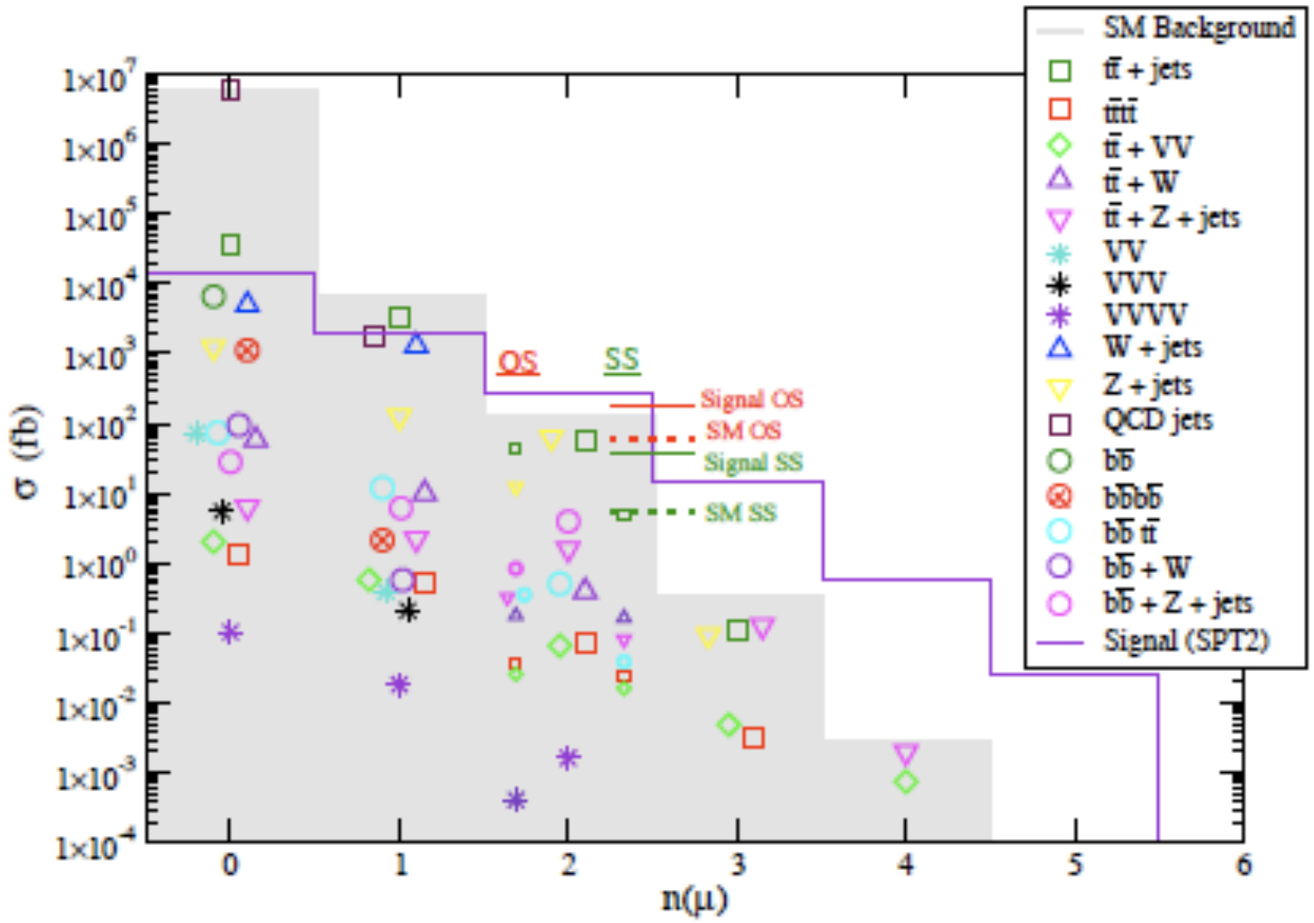

Figure 3: Cross sections for various multiplicities of isolated muons in n-muon $+\geq 4$ jet events at the LHC, with $\sqrt{s} = 10$ TeV. We show the signal levels for the SPT2 sample point by the open histogram, along with corresponding levels for various SM backgrounds.

SPT2:450, 170,0,45,+

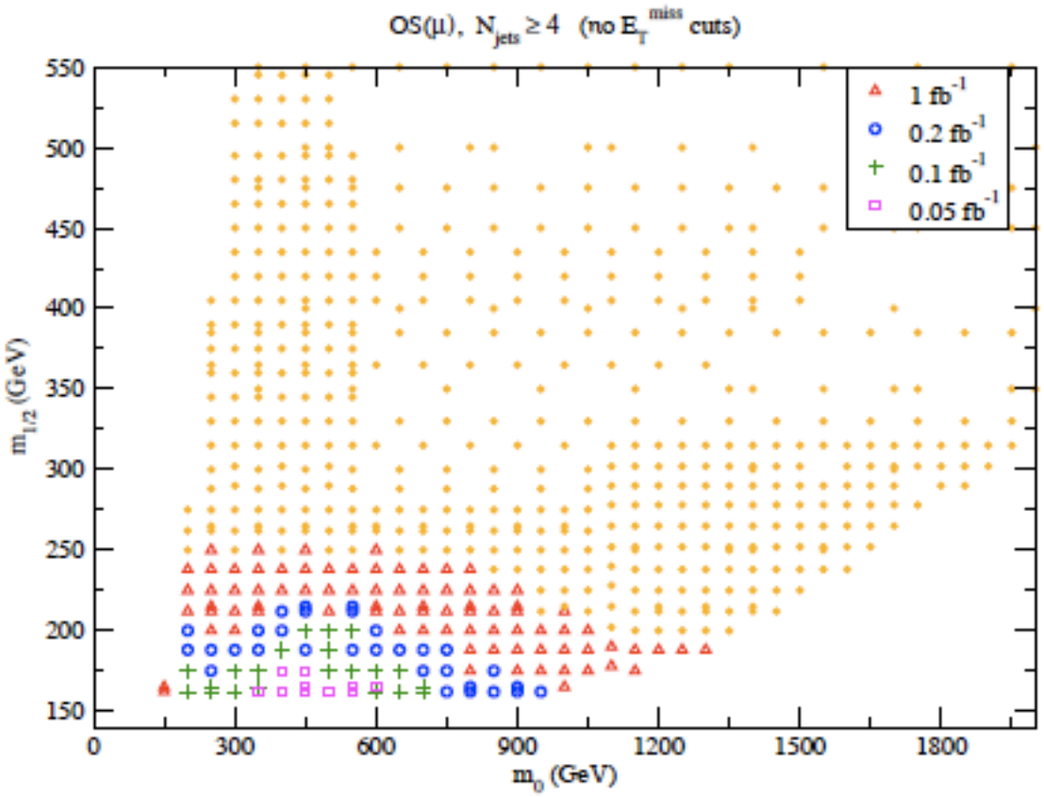

Figure 5: SUSY reach of the LHC at $\sqrt{s} = 10$ TeV via OS-dimuon plus ≥ 4 jets events with only the basic cuts detailed in the text, for various integrated luminosities.

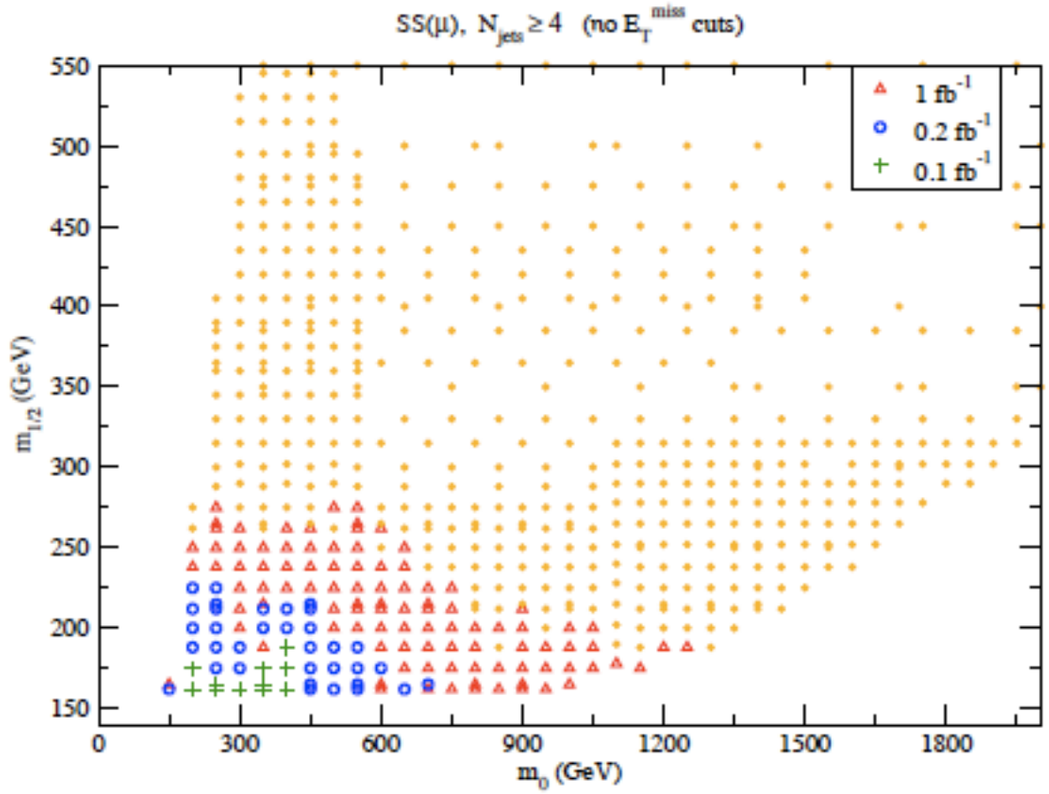

Figure 4: SUSY reach of the LHC at $\sqrt{s} = 10$ TeV via SS-dimuon plus ≥ 4 jets events with only the basic basic cuts detailed in the text, for various integrated luminosities. The solid dots here, and in other subsequent figures, denote model points where the signal remains unobservable even for the largest integrated luminosity shown in the figure.

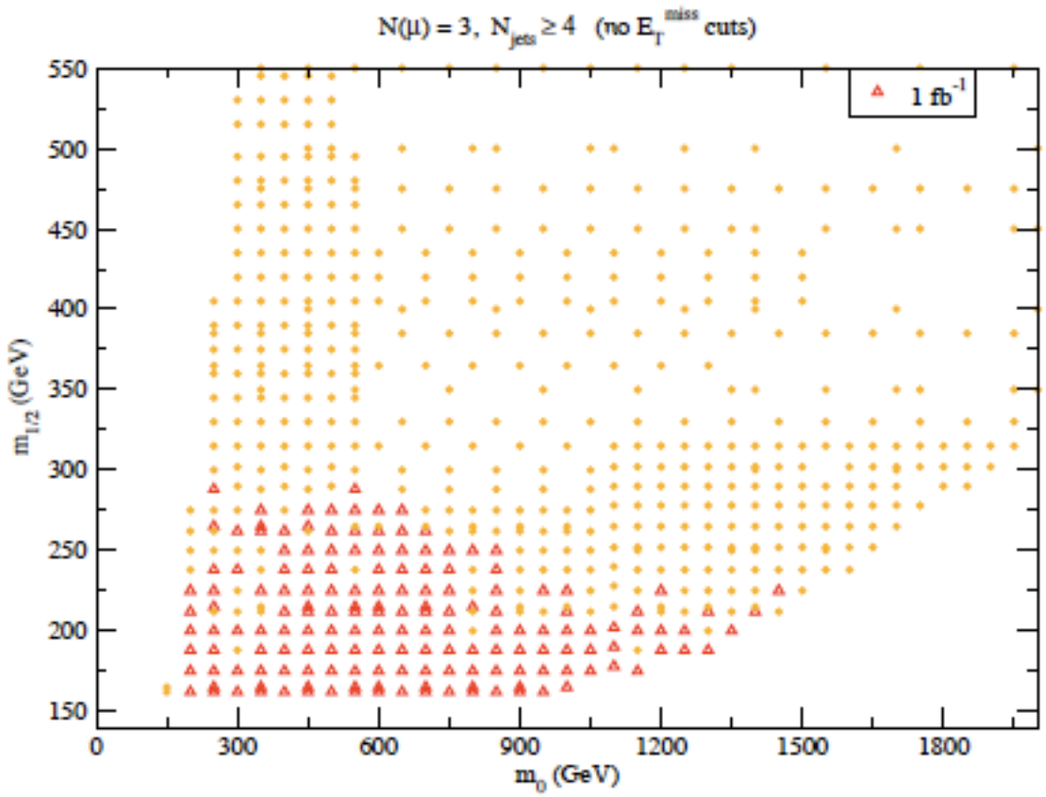

Figure 6: SUSY reach of the LHC at $\sqrt{s} = 10$ TeV via trimuon plus ≥ 4 jets events with only the basic cuts detailed in the text, for various integrated luminosities.

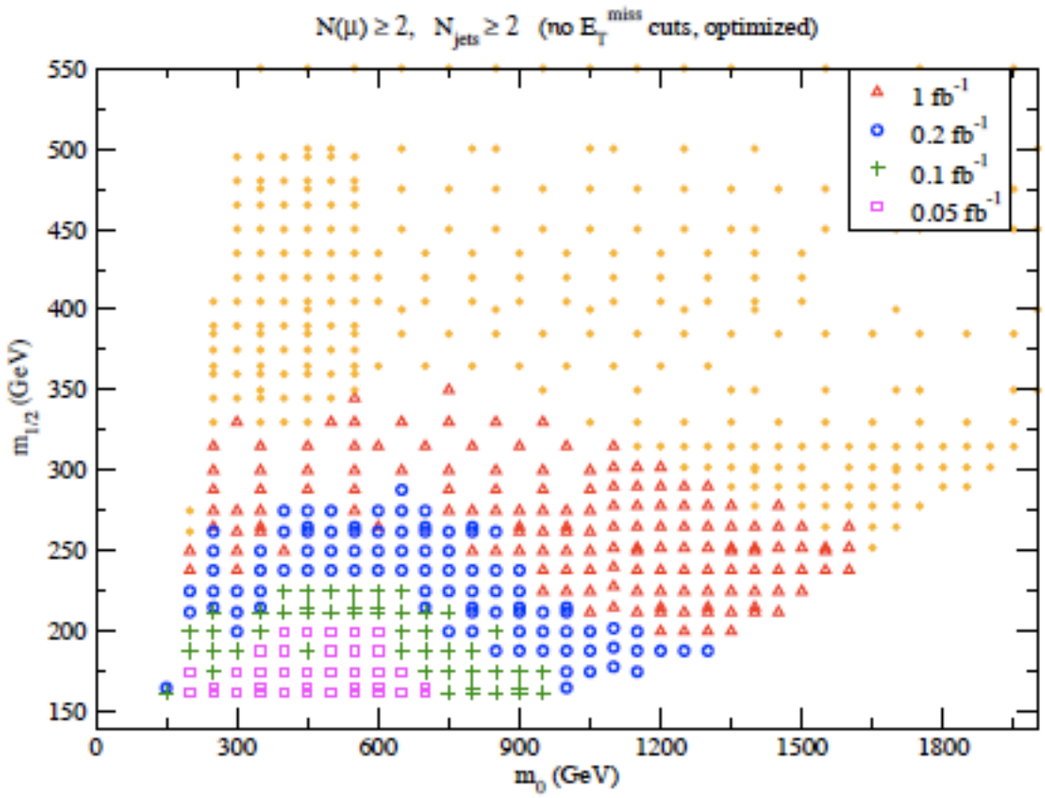

Figure 13: Reach of LHC for mSUGRA at $\sqrt{s} = 10$ TeV for multi-muon $+jets$ events using optimized cuts discussed in the text, but without any $E_T^{\rm miss}$ requirement on the signal.

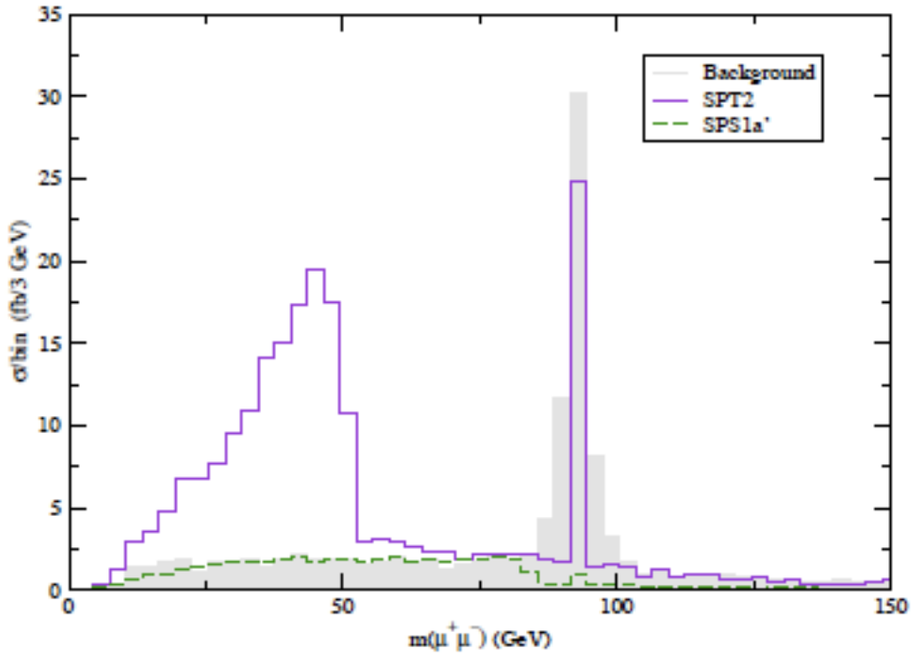

Figure 8: OS dimuon invariant mass distribution from OS dimuon + ≥ 4 jets events for SPS1a$'$ (dashed) and SPT2 (solid) cases, and also for SM backgrounds (shaded). We make no requirement on $E_T^{\rm miss}$.

Randall-Tucker-Smith dijet signal as calculated in BBLT

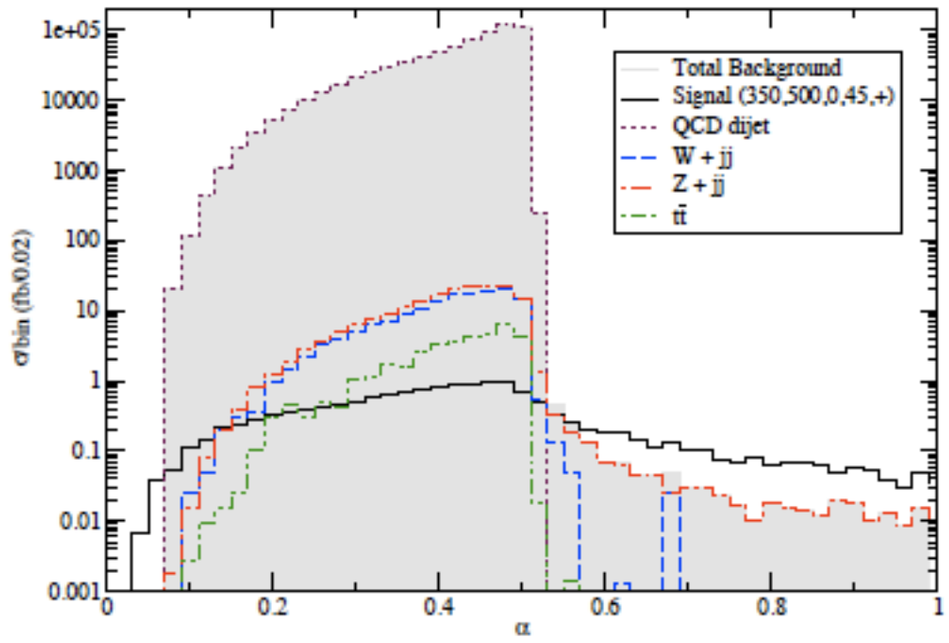

Figure 16: Distribution of α defined in the text for dijet events with no identified leptons for the mSUGRA point $m_0 = 350$ GeV, $m_{1/2} = 500$ GeV, $A_0 = 0$ GeV, $tan\beta = 45$ and $\mu > 0$ at $\sqrt{s} = 10$ TeV, along with corrresponding distributions from various SM sources. We require that $E_T(j_1) + E_T(j_2) > 700$ GeV, but make no restriction on $E_T^{\rm miss}$.

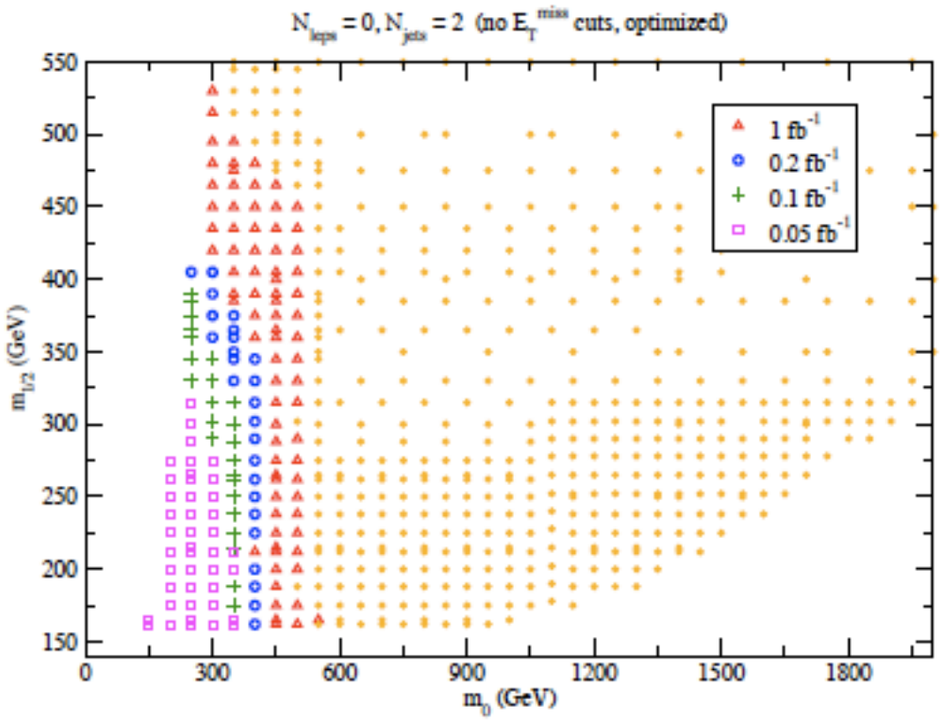

Figure 18: Optimized reach of LHC for mSUGRA at $\sqrt{s} = 10$ TeV via the RT-S dijet search, for various values of integrated luminosity. We assume that it will be possible to veto events with electrons or muons, but require no restriction on $E_T^{\rm miss}$.

Region around SPT2 is favored in mSUGRA model with mixed axion/axino DM

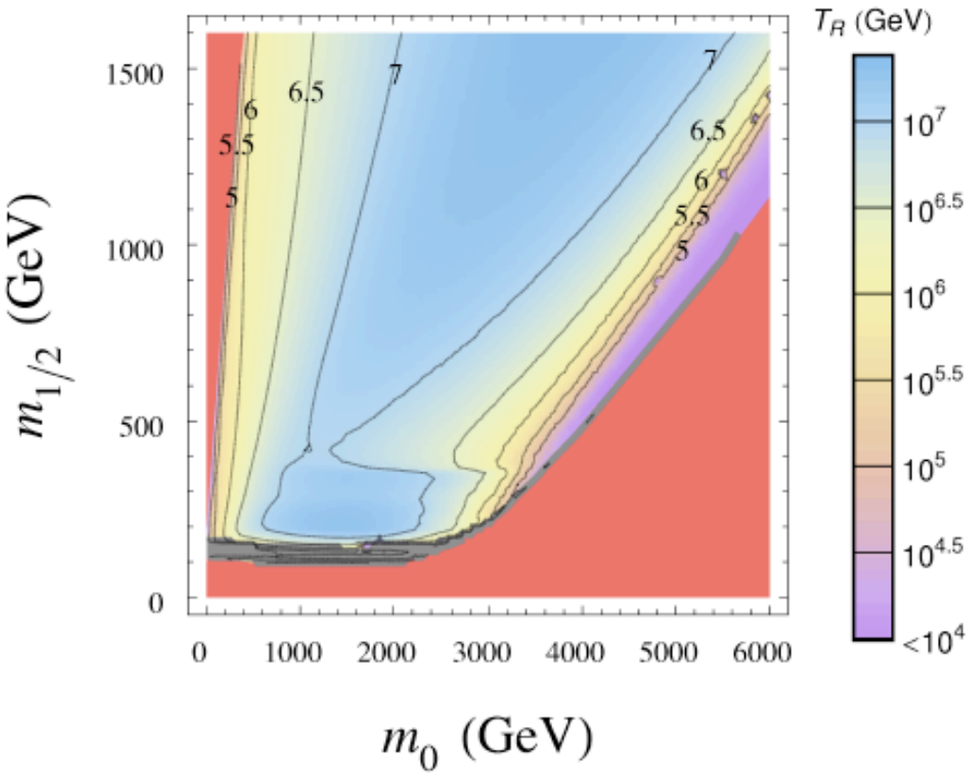

Figure 6: Contours of constant T_R in the m_0 *vs.* $m_{1/2}$ plane for $A_0 = 0$, $\tan\beta = 10$ and $\mu > 0$. We assume $\Omega_a h^2 = 0.11$, and $\Omega_{\tilde{a}}^{TP} h^2 = 0.006$ and $\Omega_{\tilde{a}}^{NTP} = 6 \times 10^{-6}$.

HB, A. Box and A. Summy,arXiv:0906.2595,
where most disfavored neutralino DM regions
are most favored with mainly axion CDM

Yukawa unified SUSY is easily susceptible to be tested by multi-muon plus jets signature with just 1 fb^-1 of LHC data

- t-b-tau unification
- m(gl)~300-500 GeV
- m(t1),m(b1),mA~1-2TeV
- m(squarks,sleptons)~1TeV
- needs mixed axion/axino DM
- details: see HB, Haider, Kraml, Sekmen, Summy, JCAP0902, 002 (2009)