

Benchmarks in use for LLP searches

There seem to be four main categories of benchmarks

1 Four SM fermions + X from scalar

1.1 SM Higgs decaying to scalars or dark photons that then decay to SM fermions

- ATLAS [2107.06092] Prompt leptonic Z + weird jets
ZH production; decay $H \rightarrow aa, a \rightarrow f\bar{f}$
- ATLAS [1811.02542] Prompt Z + weird jets
 $H \rightarrow Z\gamma_d \rightarrow (\ell^+\ell^-)jj$
- ATLAS [CONF-2020-052] Invisible higgs decay
Production via VBF or $t\bar{t}H$ with Higgs decaying invisibly
- CMS [2112.13769], Dark Photons
 $H \rightarrow \gamma_d\gamma_d \rightarrow 4\mu$
- CMS [2205.08582] Dark Photons; displaced dimuon vertex
 $H \rightarrow \gamma_d\gamma_d \rightarrow 2\mu 2j$
- ATLAS [CONF-2022-001] Dark Photons;
 $H \rightarrow \gamma_d\gamma_d \rightarrow 2e 2j$
- CMS [2110.04809] Displaced leptons
 $H \rightarrow \gamma_d\gamma_d \rightarrow (\ell^+\ell^-)(\ell^+\ell^-)$
- CMS [2107.04838] Endcap jets
 $H \rightarrow SS, S \rightarrow f\bar{f}, f = b, d, \tau.$
- ATLAS [CONF-2022-001] Dark photon but via a heavy fermion and with MET
 $H \rightarrow F_d\bar{F}_d, F_d \rightarrow \gamma_d + \text{invisible fermion}; \gamma_d \rightarrow f\bar{f}$ where $f = e, q$. For some reason called “photon” jets
- LHCb [1705.07332] Displaced vertex with di-jet
 $H \rightarrow \pi_D\pi_D \rightarrow 4f$

1.2 New heavy scalar Φ produced by gluon fusion that decays to lighter scalars to SM fermions

- ATLAS; [2203.01009] Displaced hadronic jets
 $gg \rightarrow \Phi \rightarrow SS, S \rightarrow q\bar{q}$

- ATLAS; [2203.00587] Displaced vertex
Same production with $gg \rightarrow \Phi \rightarrow SS, S \rightarrow q\bar{q}$

2 Strongly interacting hidden sector

2.1 Leptoquark-like scalar that decays to hadronizing hidden sector

- CMS [1810.10069]; strongly charged scalars decay into prompt SM jets + dark quarks which give “emerging” jets

3 Production via Z'

- CMS [2012.01581] Displaced jets
 $Z' \rightarrow XX \rightarrow 4q$
- LHCb [1910.06926] Dark photon
 $Z' \rightarrow \mu^+\mu^-$
- LHCb [2007.03923] Dark photon
 $Z' \rightarrow \mu^+\mu^-$

4 Heavy Neutral Leptons

- ATLAS [2204.11988] HNL with 1 prompt + 2 displaced leptons
 $W \rightarrow N\ell_1, N \rightarrow \ell_2\ell_3\nu$
- ATLAS [1905.09787] Same as above but with $\mu\mu$ or $e\mu$ vertex.

5 SUSY

WARNING: REMEMBER FOR SUSY YOU CAN ALWAYS CHOOSE A LARGE CROSS SECTION BY REQUIRING SQUARK/GLUINO AS THE FIRST STAGE WITH ONE ADDITIONAL MASS PARAMETER. THIS ALSO GIVES YOU SOME EXTRA PROMPT JETS THAT CAN BE USED FOR TRIGGER. THE CHARACTERISATION HERE IS BASED ON THE LLP.

5.1 Production of neutralinos which decay by RPV coupling

Neutralino Decay is in general $\tilde{\chi} \rightarrow f_1f_2f_3$ possibilities are 3 leptons, 1 lepton + 2 quarks, 3 quarks.

- CMS [2012.01581] Displaced jets

- LHCb [2110.07293] $\mu + 2b$
- ATLAS [1907.10037] LLE coupling, displaced dilepton vertex
- ATLAS [2003.11956] LQD coupling, DV+muon
- ATLAS [1504.05162] DV+jets

5.2 Production of (top) squarks or sleptons that decay via RPV

- ATLAS [1710.07171]
Decay via UDD $\tilde{t} \rightarrow d_1 d_2$ where the $d_i = d, s, b$
- CMS [2104.13474]
- CMS Leptoquark [1808.0502]
 $LQ \rightarrow \mu q, \nu q'$. Final states are $2\mu + 2j, \mu + 2j + \text{MET}$.
- CMS [2110.04809] Displaced leptons
- ATLAS [ATLAS-CONF-2018-003]
- ATLAS [2011.07812] Displaced leptons

5.3 LL Gluinos

- CMS [2012.01581] Displaced jets

6 Compressed SUSY signatures with Higgsinos or Charginos

- CMS [1806.04030]
- CMS [2103.11684]
- ATLAS [2201.02472]
- ATLAS [CONF-2022-017] $H \rightarrow NN, N \rightarrow \gamma LSP$.