# Update on

# SModelS


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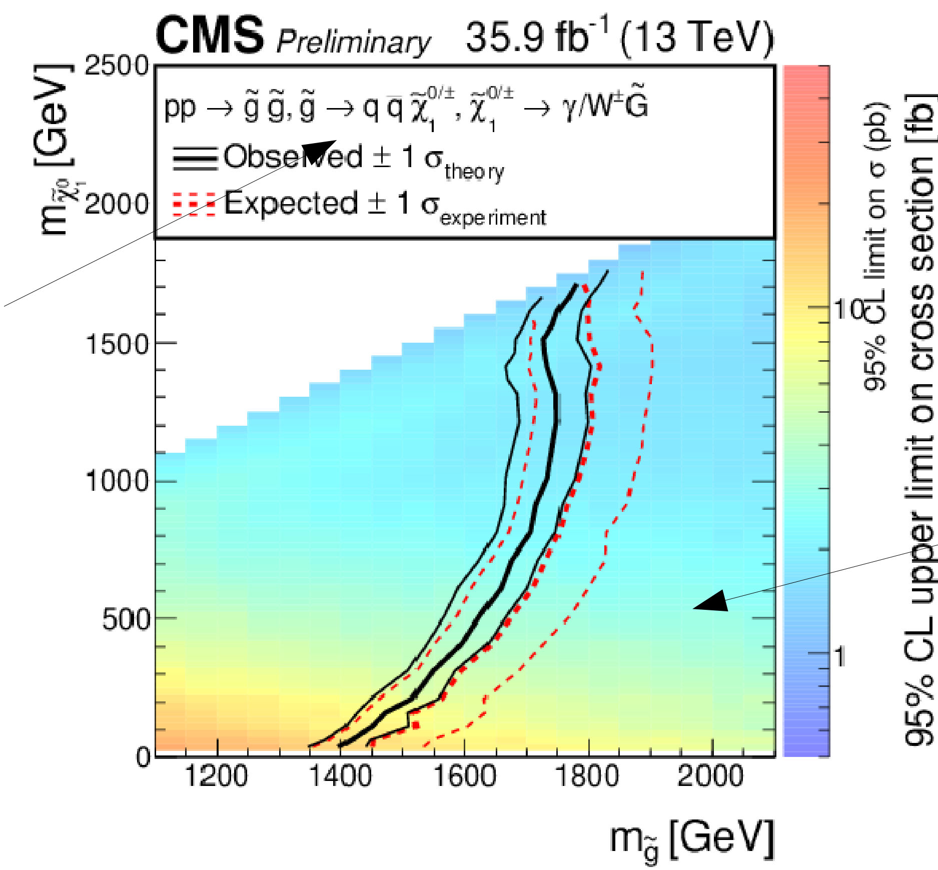
# Recap: simplified models

Simplified models are models meant to describe physics Beyond the Standard Model (BSM). Contrary to a “full” model like supersymmetry, however, they only introduce a small number (2 or 3) of new particles, allow them to decay only in one specific channel. They are meant as a tool, or a “abstraction interface” for a theorist to the results of the searches of CMS and ATLAS.

the simplified model

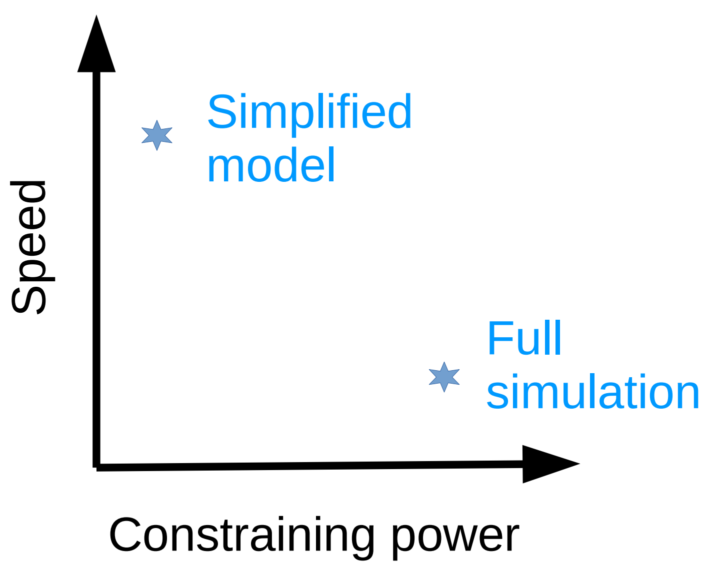


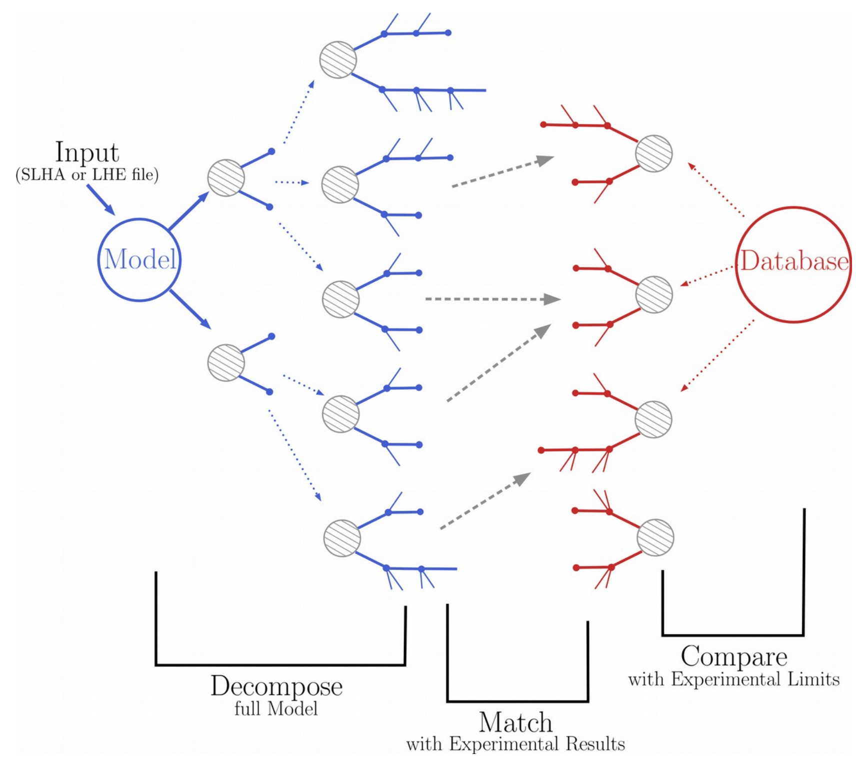

A typical simplified models result, as presented by CMS. Two massive particles ($\tilde{g}$, $\tilde{\chi}$) were introduced. The upper limits on production cross sections (the heatmap) are given as a function of the masses of these two particles.

CMS-PAS-SUS-17-012

# Recap: the Idea behind SModelS

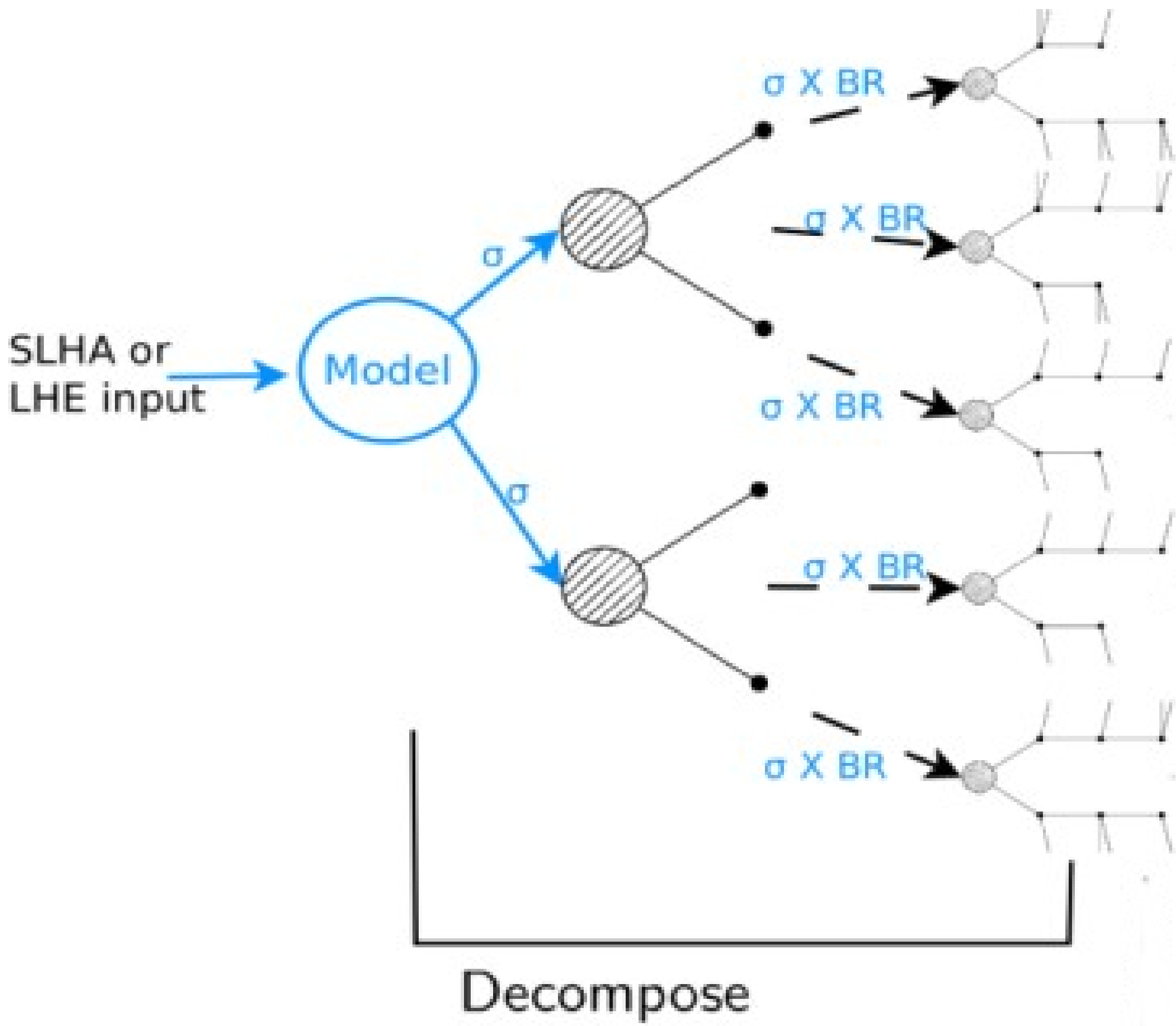
SModelS confronts theories beyond the Standard Model (BSM) with LHC search results by decomposing full models into their simplified models topologies, and comparing the cross section predictions of these individual topologies with a database of SMS results.



# Recap: How SModelS works

## 1) Decomposition of a fundamental model



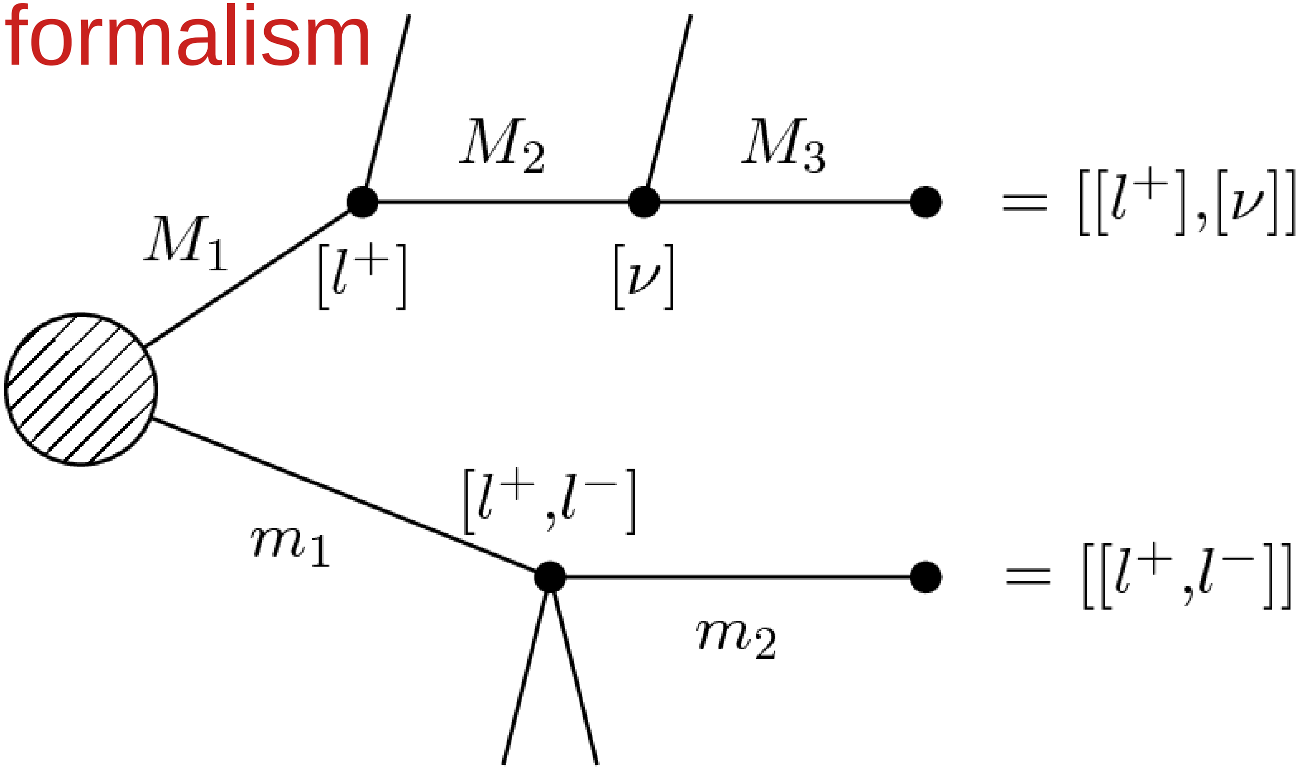

Input: SLHA file (mass spectrum, BRs) or LHE file (parton level)

Currently the model must have a **Z**$_2$ symmetry

The decomposition produces a set of simplified model topologies (dubbed "elements")

# Recap: How SModelS works

## 2) Description of the topology in the SModelS formalism




$$= [\ [[l^+],[\nu]]\ ,\ [[l^+,l^-]]\ ]$$
$$([[M_1,M_2,M_3],[m_1,m_2]])$$

**Each topology is described by:**

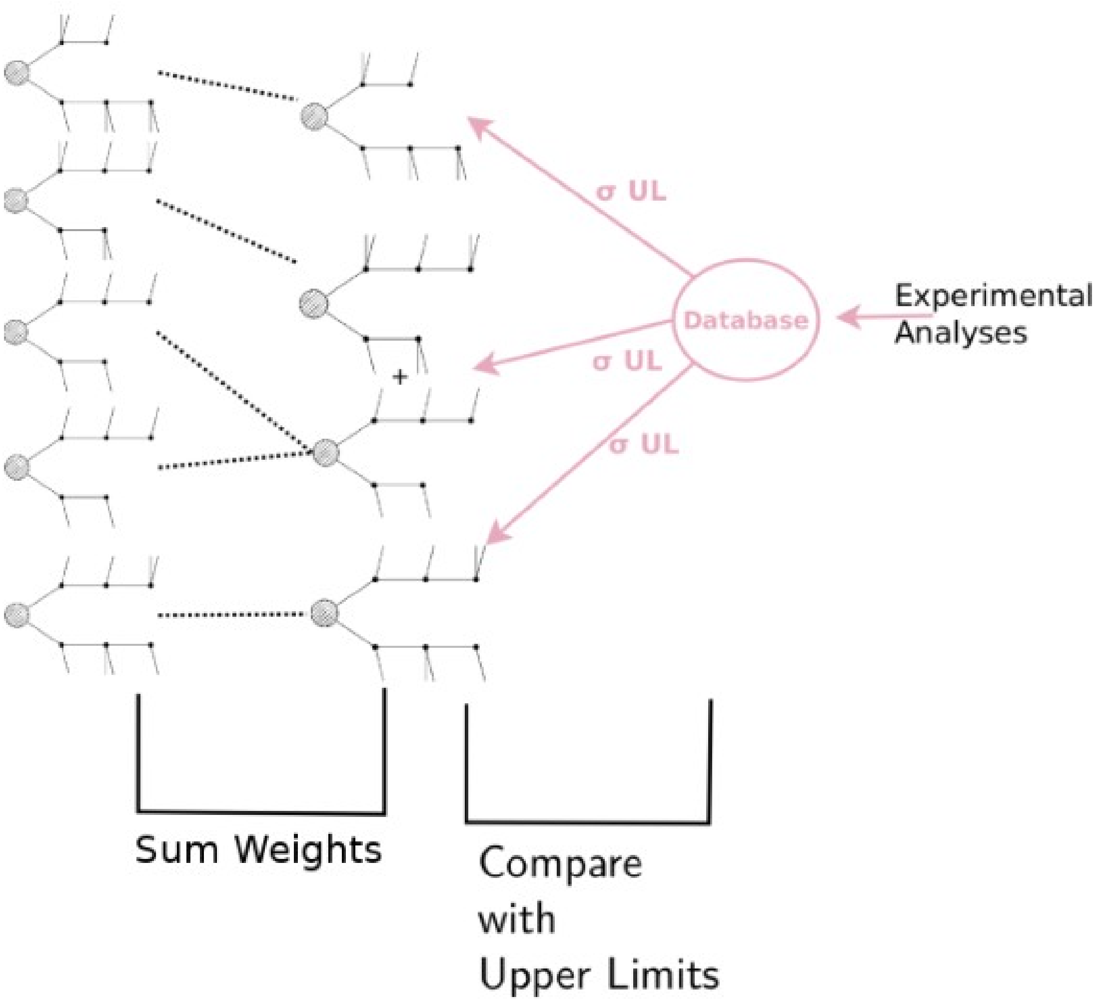
- Topology shape + final states
- BSM masses
- σ x BR

We (currently) ignore spin, color, etc of the BSM particles

It is model independent, there is no reference to the original model

# Recap: How SModelS works

## 3) Comparison of predicted signal strengths with experimental result:




- **Upper Limit Results:**
  Predicted signal strength = σ x BR
  Experimental result: $\sigma_{UL}$

- **Efficiency Map Results:**
  Predicted signal strength = ∑ σ x BR x ε
  Experimental result: $\sigma_{UL}=N_{UL}/L$ from $N_{observed}$, expected(BG), error(BG)

- r = predicted / $\sigma_{UL}$

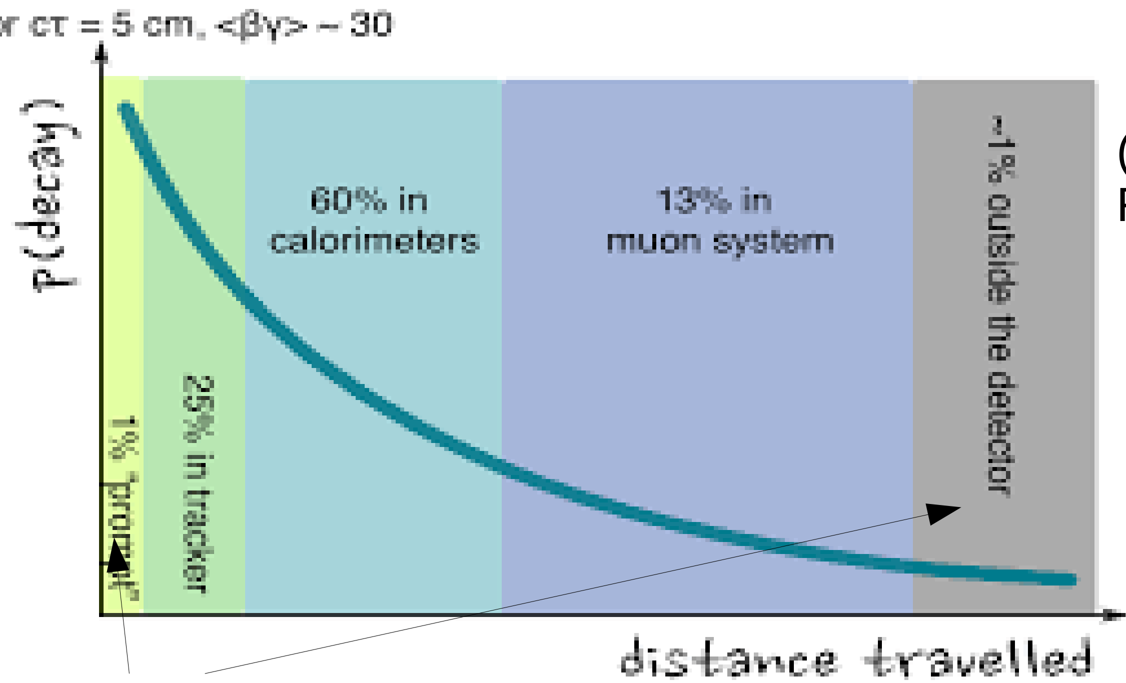
- Model is excluded if most constraining analysis has r > 1

# SModelS v1.2.2

Code and database v1.2.2 released end of november 2018. Most important novelties in v1.2.x are:

- Can now deal with Heavy Stable Charged Particles and R-Hadrons (before we could only treat prompt signatures with “missing energy” final states)
- Combination of signal regions exploiting the simplified likelihoods introduced by CMS
- Much larger database of experimental results (almost 100 analyses)

# Heavy Stable Charged Particles and R-Hadrons



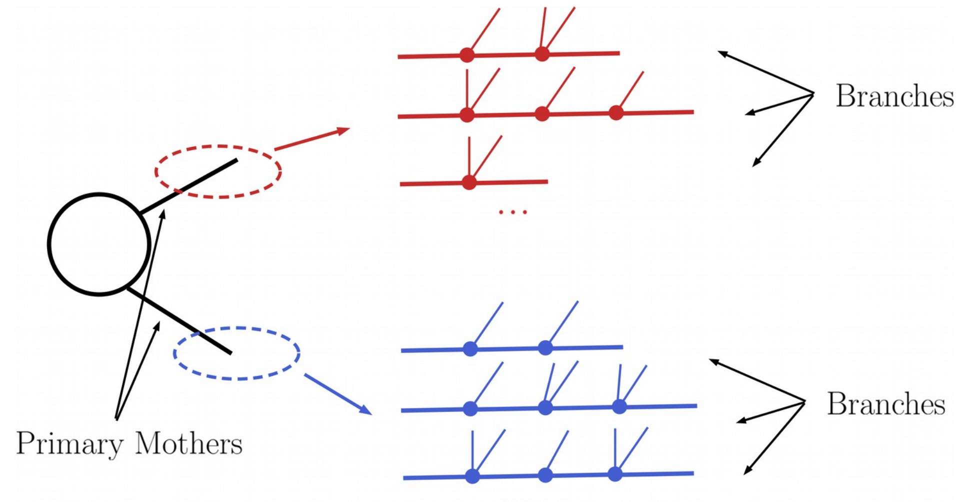

(plot stolen from H. Russell, ATLAS)

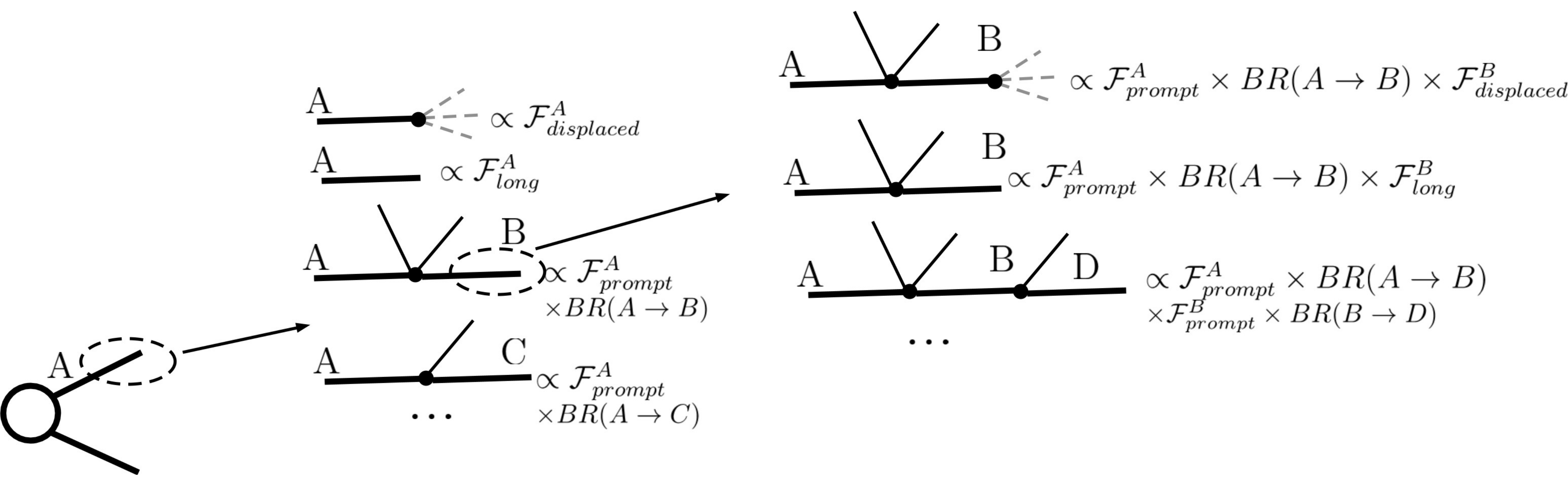
In v1.2.x we make use of the “promp” and “detector stable” fractions of a meta-stable BSM particle, but not displaced signatures.

Starting with v1.2 we make our first moves towards signatures other than missing energy: we can now treat R-Hadrons and Heavy Stable Charged Particles (HSCP), but not yet “displaced” signatures (i.e. BSM particles that decay inside of the detector but outside of the beampipe.

# Heavy Stable Charged Particles and R-Hadrons

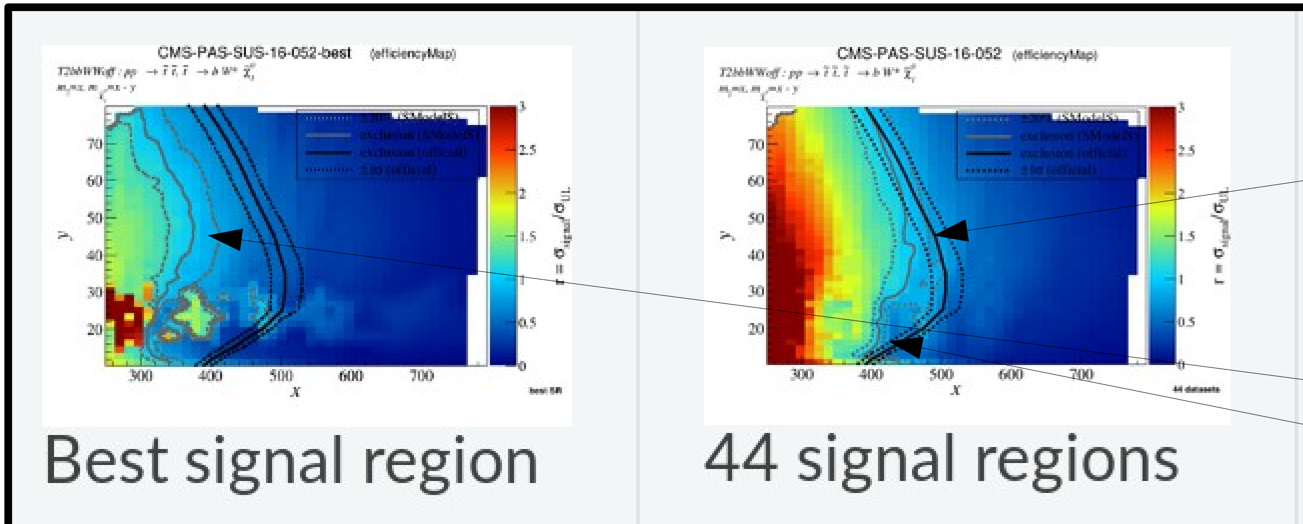
For v.1.2.x we had to extend our decomposition procedure, and compute the fractions of BSM particles that decays promptly, and the detector-stable fractions.



# Combination of signal regions

We can now make use of the simplified likelihoods published by the CMS collaboration to combine signal regions into a single joint likelihood for an analysis. Previously we could only make use of the “best” signal region, which is much less constraining.




dark black line: official CMS exclusion line (everything to its left is excluded)

continuous grey line: our exclusions. for best signal region (left) and combined regions (right)

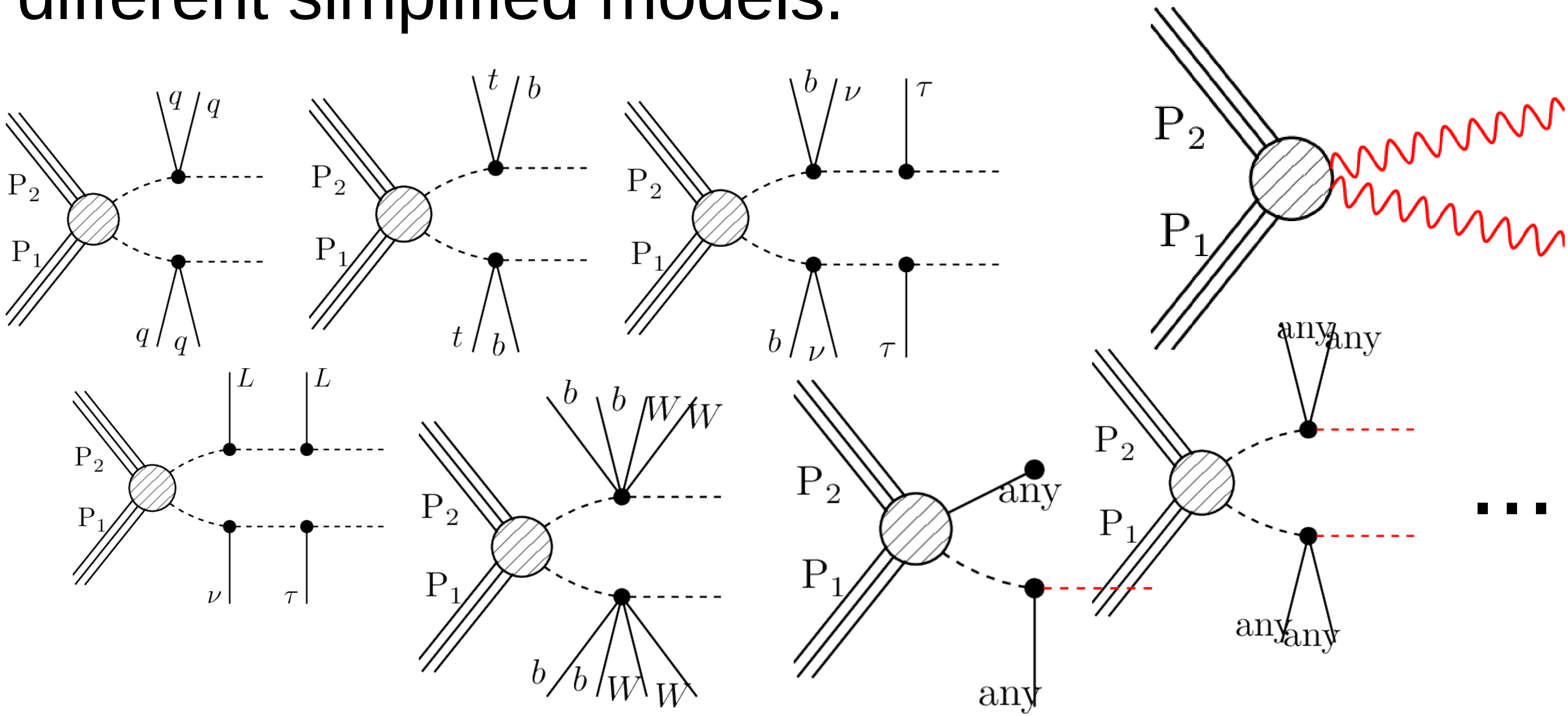
simplified likelihood v1: the combined likelihood is modeled as multivariate Gaussian for the nuisances and one Poissonian for each signal region.

$$\mathcal{L}_S(\mu, \boldsymbol{\theta}) = \prod_{i=1}^{N} \frac{(\mu \cdot s_i + b_i + \theta_i)^{n_i} e^{-(\mu \cdot s_i + b_i + \theta_i)}}{n_i!} \cdot \exp\left(-\frac{1}{2}\boldsymbol{\theta}^T \mathbf{V}^{-1} \boldsymbol{\theta}\right)$$

Simplified likelihoods:
v1: CMS-NOTE-2017-001
v2: arXiv:1809.05548 (adds a skewness term, publication in progress)

# Simplified models

The current database v1.2.2 has results for 76 different simplified models.




Currently, we do not care about the quantum numbers of the BSM particles other than their masses (thats why we the BSM particles are unspecified in the graphs above). Currently we are still restricted to models with a $Z_2$ symmetry.

https://smodels.github.io/docs/SmsDictionary

# SModelS database

| # | ID | pretty name | Topologies | Type | $\mathcal{L}$ [$fb^{-1}$] |
|---|---|---|---|---|---|
| 1 | ATLAS-SUSY-2015-01 | 2 b-jets + $\not{E}_T$ | 1: T2bb | ul | 3.2 |
| 2 | ATLAS-SUSY-2015-02 | single l stop | 1: T2tt | ul | 3.2 |
| | ATLAS-SUSY-2015-02 | single l stop | 1: T2tt | eff | 3.2 |
| 3 | ATLAS-SUSY-2015-06 | 0 l's + 2-6 jets + $\not{E}_T$ | 2: T1, T2 | eff | 3.2 |
| 4 | ATLAS-SUSY-2015-09 | jets + 2 SS l's or >=3 l's | 1: T1tttt | ul | 3.2 |
| 5 | ATLAS-SUSY-2016-14 | 2 SS or 3 l's + jets + $\not{E}_T$ | 3: T1tt[off]tt, T1tttt[off]... | ul | 36.1 |
| 6 | ATLAS-SUSY-2016-17 | 2 opposite sign l's + $\not{E}_T$ | 2: T2bbWW[off], T2tt[off]... | ul | 36.1 |
| 7 | ATLAS-SUSY-2016-19 | stops to staus | 1: T4bnutaubnutau... | ul | 36.1 |
| 8 | ATLAS-SUSY-2016-26 | >=2 c jets + $\not{E}_T$ | 1: T2cc | ul | 36.1 |
| 9 | ATLAS-SUSY-2016-33 | 2 OSSF l's + $\not{E}_T$ | 2: T5ZZ, T6ZZ | ul | 36.1 |
| 10 | ATLAS-SUSY-2017-03 | multi-l EWK searches | 1: TChiWZ | ul | 36.1 |
| 11 | ATLAS-CONF-2012-105 | 2 SS l's + >= 4 jets + $\not{E}_T$ | 1: T1tttt | ul | 5.8 |
| 12 | ATLAS-CONF-2012-166 | 1 l + 4(1 b-)jets + $\not{E}_T$ | 1: T2tt | ul | 13.0 |
| 13 | ATLAS-CONF-2013-001 | 0 l's + 2 b-jets + $\not{E}_T$ | 1: T6bbWW[off] | ul | 12.8 |
| 14 | ATLAS-CONF-2013-007 | 2 SS l's + 0-3 b-jets + $\not{E}_T$ | 4: T1btbt, T1tttt... | ul | 20.7 |
| 15 | ATLAS-CONF-2013-024 | 0 l + 6 (2 b-)jets + $\not{E}_T$ | 1: T2tt | ul | 20.5 |
| | ATLAS-CONF-2013-024 | 0 l + 6 (2 b-)jets + $\not{E}_T$ | 21: T1bbbb, T1bbbt... | eff | 20.5 |
| 16 | ATLAS-CONF-2013-025 | >= 5 (>=1 b-)jets + 2, 3 SFOS l's + $\not{E}_T$ | 1: T6ZZtt | ul | 20.7 |
| 17 | ATLAS-CONF-2013-035 | 3 l's (e,mu) + $\not{E}_T$ | 2: TChiChipmSlepL... | ul | 20.7 |
| 18 | ATLAS-CONF-2013-037 | 1 l + >= 4(1 b-)jets + $\not{E}_T$ | 1: T2tt | ul | 20.7 |
| | ATLAS-CONF-2013-037 | 1 l + >= 4(1 b-)jets + $\not{E}_T$ | 18: T1bbbb, T1bbbt... | eff | 20.7 |
| 19 | ATLAS-CONF-2013-047 | 0 l's + 2-6 jets + $\not{E}_T$ | 3: T1, T5WW[off]... | ul | 20.3 |
| | ATLAS-CONF-2013-047 | 0 l's + 2-6 jets + $\not{E}_T$ | 24: T1, T1bbbb, T1bbbt... | eff | 20.3 |
| 20 | ATLAS-CONF-2013-048 | 2 l's + (b-)jets + $\not{E}_T$ | 2: T2bbWW, T6bbWW[off]... | ul | 20.3 |
| | ATLAS-CONF-2013-048 | 2 l's + (b)jets + $\not{E}_T$ | 11: T1bbtt, T1btbt... | eff | 20.3 |
| 21 | ATLAS-CONF-2013-049 | 2 l's (e,mu) + $\not{E}_T$ | 1: TSlepSlep | ul | 20.3 |
| 22 | ATLAS-CONF-2013-053 | 0 l's + 2 b-jets + $\not{E}_T$ | 1: T2bb | ul | 20.1 |
| | ATLAS-CONF-2013-053 | 0 l's + 2 b-jets + $\not{E}_T$ | 17: T1bbbb, T1bbbt... | eff | 20.1 |
| 23 | ATLAS-CONF-2013-054 | 0 l's + >= 7-10 jets + $\not{E}_T$ | 24: T1, T1bbbb, T1bbbt... | eff | 20.3 |
| 24 | ATLAS-CONF-2013-061 | jets + >= 3 b-jets + $\not{E}_T$ | 3: T1bbbb, T1btbt... | ul | 20.1 |
| | ATLAS-CONF-2013-061 | jets + >= 3 b-jets + $\not{E}_T$ | 21: T1bbbb, T1bbbt... | eff | 20.1 |
| 25 | ATLAS-CONF-2013-062 | 1 l + jets + $\not{E}_T$ | 21: T1, T1bbbb, T1bbbt... | eff | 20.3 |
| 26 | ATLAS-CONF-2013-065 | 2 l's + (b-)jets + $\not{E}_T$ | 2: T2tt, T6bbWW | ul | 20.3 |
| 27 | ATLAS-CONF-2013-089 | 2 l's (e,mu) + $\not{E}_T$ | 1: T6WW | ul | 20.3 |
| 28 | ATLAS-CONF-2013-093 | 1 l + 2 b-jets + $\not{E}_T$ | 1: TChiWH | ul | 20.3 |
| | ATLAS-CONF-2013-093 | 1 l + 2 b-jets + $\not{E}_T$ | 6: T1bbbt, T2bt, T2tt... | eff | 20.3 |
| 29 | ATLAS-SUSY-2013-02 | 0 l's + 2-6 jets + $\not{E}_T$ | 5: T1, T2, T5WW[off]... | ul | 20.3 |
| | ATLAS-SUSY-2013-02 | jets and met | 4: T1, T2, T3GQ, T5... | eff | 20.3 |
| 30 | ATLAS-SUSY-2013-04 | 0 l's + >= 7-10 jets + $\not{E}_T$ | 1: T1tttt | ul | 20.3 |
| | ATLAS-SUSY-2013-04 | 0 l's + >= 7-10 jets + $\not{E}_T$ | 8: T1bbbb, T1btbt... | eff | 20.3 |
| 31 | ATLAS-SUSY-2013-05 | 0 l's + 2 b-jets + $\not{E}_T$ | 2: T2bb, T6bbWW[off]... | ul | 20.1 |
| | ATLAS-SUSY-2013-05 | 0 l's + 2 b-jets + $\not{E}_T$ | 1: T2bb | eff | 20.1 |
| 32 | ATLAS-SUSY-2013-08 | Z + b-jets + $\not{E}_T$ | 1: T6ZZtt | ul | 20.3 |
| 33 | ATLAS-SUSY-2013-09 | 2 SS l's + $\not{E}_T$ | 1: T1tttt | ul | 20.3 |
| 34 | ATLAS-SUSY-2013-11 | 2 l's (e,mu) + $\not{E}_T$ | 4: TChiWW, TChiWZ... | ul | 20.3 |
| | ATLAS-SUSY-2013-11 | 2 l's (e,mu) + $\not{E}_T$ | 3: TChiWW[off], TChipChimSlepSnu... | eff | 20.3 |
| 35 | ATLAS-SUSY-2013-12 | 3 l's (e,mu,tau) + $\not{E}_T$ | 4: TChiChipmSlepL... | ul | 20.3 |
| 36 | ATLAS-SUSY-2013-15 | 1 l + 4 (1 b-)jets + $\not{E}_T$ | 1: T2tt | ul | 20.3 |
| | ATLAS-SUSY-2013-15 | 1 l + 4 (1 b-)jets + $\not{E}_T$ | 1: T2tt | eff | 20.3 |
| 37 | ATLAS-SUSY-2013-16 | 0 l + 6 (2 b-)jets + $\not{E}_T$ | 1: T2tt | ul | 20.1 |
| | ATLAS-SUSY-2013-16 | 0 l + 6 (2 b-)jets + $\not{E}_T$ | 1: T2tt | eff | 20.1 |
| 38 | ATLAS-SUSY-2013-18 | 0-1 l's + >= 3 b-jets + $\not{E}_T$ | 2: T1bbbb, T1tttt... | ul | 20.1 |
| | ATLAS-SUSY-2013-18 | 0-1 l's + >= 3 b-jets + $\not{E}_T$ | 2: T1bbbb, T1tttt... | eff | 20.1 |
| 39 | ATLAS-SUSY-2013-19 | 2 OS l's + (b-)jets + $\not{E}_T$ | 2: T2bbWW, T2tt | ul | 20.3 |
| 40 | ATLAS-SUSY-2013-21 | monojet or c-jet + $\not{E}_T$ | 3: T2bb, T2bbWW[off]... | eff | 20.3 |
| 41 | ATLAS-SUSY-2013-23 | 1 l + 2 b-jets (or 2 $\gamma$s) + $\not{E}_T$ | 1: TChiWH | ul | 20.3 |
| 42 | ATLAS-SUSY-2014-03 | >= 2(c-)jets + $\not{E}_T$ | 1: TScharm | eff | 20.3 |

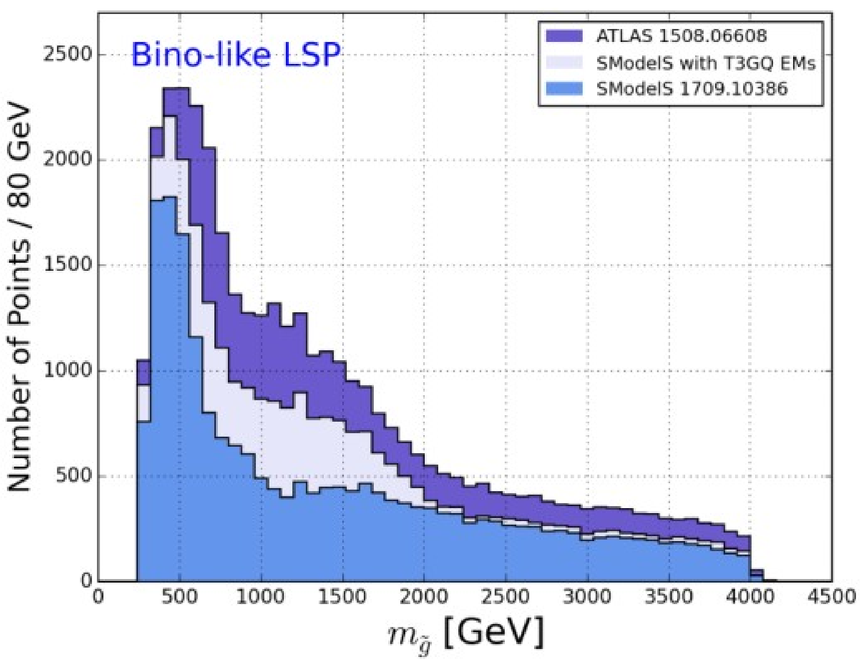
| # | ID | pretty name | Topologies | Type | $\mathcal{L}$ [$fb^{-1}$] | $\sqrt{s}$ |
|---|---|---|---|---|---|---|
| 1 | CMS-PAS-EXO-16-036 | hscp search | 3: THSCPM1b, TRHadGM1... | ul | 12.9 | 13 |
| | CMS-PAS-EXO-16-036 | hscp search | 8: THSCPM1b, THSCPM2b... | eff | 12.9 | 13 |
| 2 | CMS-PAS-SUS-15-002 | >= 4jets + $\not{E}_T$, HT, HTmiss | 2: T1, T1bbbb | ul | 2.2 | 13 |
| 3 | CMS-PAS-SUS-16-014 | jets + $\not{E}_T$, HT | 6: T1, T1bbbb, T1tttt[off]... | ul | 12.9 | 13 |
| 4 | CMS-PAS-SUS-16-015 | jets + $\not{E}_T$, MT2 | 6: T1, T1bbbb, T1tttt[off]... | ul | 12.9 | 13 |
| 5 | CMS-PAS-SUS-16-016 | >= 1 jet + $\not{E}_T$, $\alpha_T$ | 4: T1bbbb, T1tttt[off]... | ul | 12.9 | 13 |
| 6 | CMS-PAS-SUS-16-019 | jets + 1 l | 1: T1tttt[off] | ul | 12.9 | 13 |
| 7 | CMS-PAS-SUS-16-022 | >= 3 l's + $\not{E}_T$ | 1: T1tttt[off] | ul | 12.9 | 13 |
| 8 | CMS-PAS-SUS-16-052 | soft l, <= 2 jets | 2: T2bbWW[off], T6bbWW[off]... | ul | 35.9 | 13 |
| 9 | CMS-PAS-SUS-16-052-agg | soft l, <= 2 jets | 2: T2bbWW[off], T6bbWW[off]... | eff | 35.9 | 13 |
| 10 | CMS-PAS-SUS-17-004 | multi-l EWK searches | 2: TChiWH, TChiWZ[off]... | ul | 35.9 | 13 |
| 11 | CMS-SUS-15-002 | multijets + $\not{E}_T$, HT | 3: T1, T1bbbb, T1tttt[off]... | ul | 2.2 | 13 |
| 12 | CMS-SUS-15-008 | SS dil | 1: T1tttt[off] | ul | 2.3 | 13 |
| 13 | CMS-SUS-16-032 | Sbottom and compressed stop | 2: T2bb, T2cc | ul | 35.9 | 13 |
| 14 | CMS-SUS-16-033 | 0L + jets + $\not{E}_T$ | 6: T1, T1bbbb, T1tttt[off]... | ul | 35.9 | 13 |
| 15 | CMS-SUS-16-034 | 2 OSSF l's | 2: T5ZZ, TChiWZ | ul | 35.9 | 13 |
| 16 | CMS-SUS-16-035 | 2 SS l's | 7: T1tttt[off], T5WW[off]... | ul | 35.9 | 13 |
| 17 | CMS-SUS-16-036 | 0L + jets + $\not{E}_T$ | 8: T1, T1bbbb, T1tttt[off]... | ul | 35.9 | 13 |
| 18 | CMS-SUS-16-037 | 1L + jets + $\not{E}_T$ with MJ | 3: T1tttt[off], T5tt[off]tt... | ul | 35.9 | 13 |
| 19 | CMS-SUS-16-039 | multi-l EWK searches | 5: TChiChipmSlepL... | ul | 35.9 | 13 |
| 20 | CMS-SUS-16-041 | multi-ls + jets + $\not{E}_T$ | 6: T1tttt[off], T6HHtt... | ul | 35.9 | 13 |
| 21 | CMS-SUS-16-042 | 1L + jets + $\not{E}_T$ | 2: T1tttt[off], T5WW[off]... | ul | 35.9 | 13 |
| 22 | CMS-SUS-16-043 | EWK WH | 1: TChiWH | ul | 35.9 | 13 |
| 23 | CMS-SUS-16-045 | Sbottom to bHbH and H $\to \gamma\gamma$ | 2: T6bbHH, TChiWH... | ul | 35.9 | 13 |
| 24 | CMS-SUS-16-046 | $\gamma$ + $\not{E}_T$ | 2: T5gg, T6gg | ul | 35.9 | 13 |
| 25 | CMS-SUS-16-047 | $\gamma$ + HT | 2: T5gg, T6gg | ul | 35.9 | 13 |
| 26 | CMS-SUS-16-049 | All hadronic stop | 4: T2cc, T2ttC, T2tt[off]... | ul | 35.9 | 13 |
| 27 | CMS-SUS-16-050 | 0L + top tag | 4: T1tttt[off], T2tt[off]... | ul | 35.9 | 13 |
| 28 | CMS-SUS-16-051 | 1L stop | 2: T2tt[off], T6bbWW... | ul | 35.9 | 13 |
| 29 | CMS-SUS-17-001 | Stop search in dil + jets + $\not{E}_T$ | 2: T2tt[off], T6bbWW... | ul | 35.9 | 13 |
| 30 | CMS-EXO-12-026 | hscp search | 3: THSCPM1b, TRHadGM1... | ul | 18.8 | 8 |
| 31 | CMS-EXO-13-006 | hscp search | 8: THSCPM1b, THSCPM2b... | eff | 18.8 | 8 |
| 32 | CMS-PAS-SUS-12-022 | multi-l + $\not{E}_T$ | 6: TChiChipmSlepL... | ul | 9.2 | 8 |
| 33 | CMS-PAS-SUS-12-026 | >= 3 l's (+jets) + $\not{E}_T$ | 1: T1tttt | ul | 9.2 | 8 |
| 34 | CMS-PAS-SUS-13-015 | >= 5(1b-)jets + $\not{E}_T$ | 1: T2tt[off] | eff | 19.4 | 8 |
| 35 | CMS-PAS-SUS-13-016 | 2 OS l's + >= 4 (2 b-)jets + $\not{E}_T$ | 1: T1tttt[off] | ul | 19.7 | 8 |
| | CMS-PAS-SUS-13-016 | 2 OS l's + >= 4 (2b-)jets + $\not{E}_T$ | 1: T1tttt[off] | eff | 19.7 | 8 |
| 36 | CMS-PAS-SUS-13-018 | 1-2 b-jets + $\not{E}_T$, $M_CT$ | 1: T2bb | ul | 19.4 | 8 |
| 37 | CMS-PAS-SUS-13-023 | hadronic stop | 2: T2tt[off], T6bbWW[off]... | ul | 18.9 | 8 |
| 38 | CMS-PAS-SUS-14-011 | razor with b-jets | 3: T1bbbb, T1tttt[off]... | ul | 19.3 | 8 |
| 39 | CMS-SUS-12-024 | 0 l's + >= 3 (1b-)jets + $\not{E}_T$ | 1: T1tttt[off] | ul | 19.4 | 8 |
| | CMS-SUS-12-024 | 0 l's + >= 3 (1b-)jets + $\not{E}_T$ | 2: T1bbbb, T1tttt[off]... | eff | 19.4 | 8 |
| 40 | CMS-SUS-12-028 | jets + $\not{E}_T$, $\alpha_T$ | 5: T1, T1bbbb, T1tttt... | ul | 11.7 | 8 |
| 41 | CMS-SUS-13-002 | >= 3 l's (+jets) + $\not{E}_T$ | 1: T1tttt | ul | 19.5 | 8 |
| 42 | CMS-SUS-13-004 | >= 1 b-jet + $\not{E}_T$, Razor | 3: T1bbbb, T1tttt[off]... | ul | 19.3 | 8 |
| 43 | CMS-SUS-13-006 | EW prod. to l's, W, Z, and H | 5: TChiChipmSlepL... | ul | 19.5 | 8 |
| 44 | CMS-SUS-13-007 | 1 l + >= 2 b-jets + $\not{E}_T$ | 2: T1tttt[off], T5tttt... | ul | 19.3 | 8 |
| | CMS-SUS-13-007 | 1 l + >= 2 b-jets + $\not{E}_T$ | 1: T1tttt[off] | eff | 19.3 | 8 |
| 45 | CMS-SUS-13-011 | 1 l + >= 4 (1b-)jets + $\not{E}_T$ | 2: T2tt[off], T6bbWW[off]... | ul | 19.5 | 8 |
| | CMS-SUS-13-011 | 1 l + >= 4 (1b-)jets + $\not{E}_T$ | 1: T2tt[off] | eff | 19.5 | 8 |
| 46 | CMS-SUS-13-012 | $n_{jets}$ + HTmiss | 3: T1, T1tttt[off]... | ul | 19.5 | 8 |
| | CMS-SUS-13-012 | $n_{jets}$ + HTmiss | 19: T1, T1bbbb, T1btbt... | eff | 19.5 | 8 |
| 47 | CMS-SUS-13-013 | 2 SS l's + (b-)jets + $\not{E}_T$ | 2: T1tttt[off], T6ttWW[off]... | ul | 19.5 | 8 |
| | CMS-SUS-13-013 | 2 SS l's + (b-)jets + $\not{E}_T$ | 1: T1tttt[off] | eff | 19.5 | 8 |
| 48 | CMS-SUS-13-019 | >= 2 jets + $\not{E}_T$, MT2 | 6: T1, T1bbbb, T1tttt[off]... | ul | 19.5 | 8 |
| 49 | CMS-SUS-14-010 | b-jets + 4 Ws | 1: T1tttt[off] | ul | 19.5 | 8 |
| 50 | CMS-SUS-14-021 | soft l's, low $n_{jets}$, high $\not{E}_T$ | 1: T2bbWW[off] | ul | 19.7 | 8 |

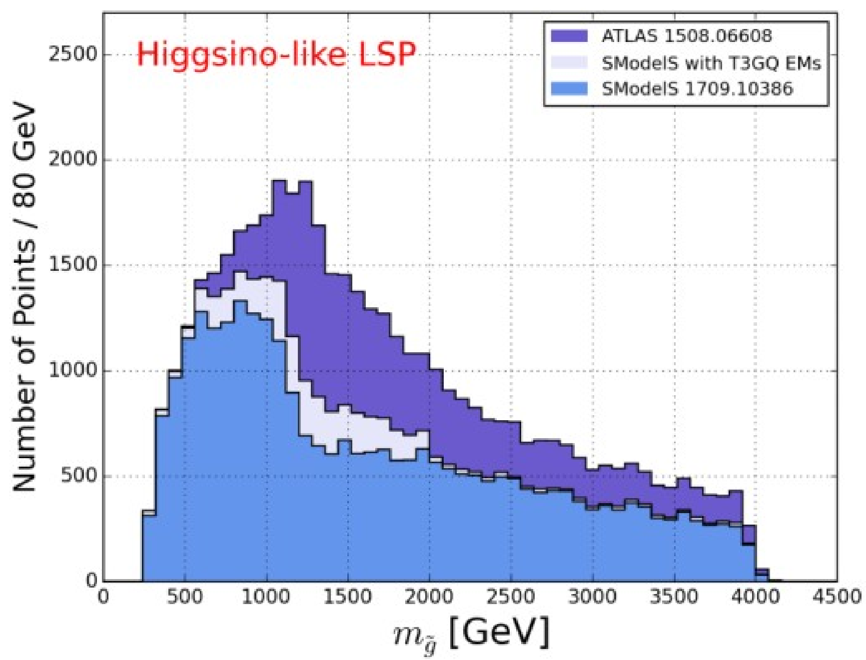
We collect the results of the experimental collaborations, and augment them with recast analyses (MadAnalysis5, CheckMATE), creating our own efficiency maps. In addition, fastlim kindly allowed us to also use their efficiency maps. SModelS v1.2.2 ships with results of almost 100 different analyses.

https://smodels.github.io/docs/ListOfAnalyses

# SModelS – trading in constraining power for speed

In comparison with recasting methods like MadAnalysis and CheckMATE, SModelS exclusions are more conservative, but much faster. A direct comparison with an ATLAS pMSSM scan [arXiv:1508.06608] gave us a clue as to how much more conservative we are, and which topologies we miss out on (i.e. the analyses are in principle sensitive to, but no interpretations for these topologies are published).



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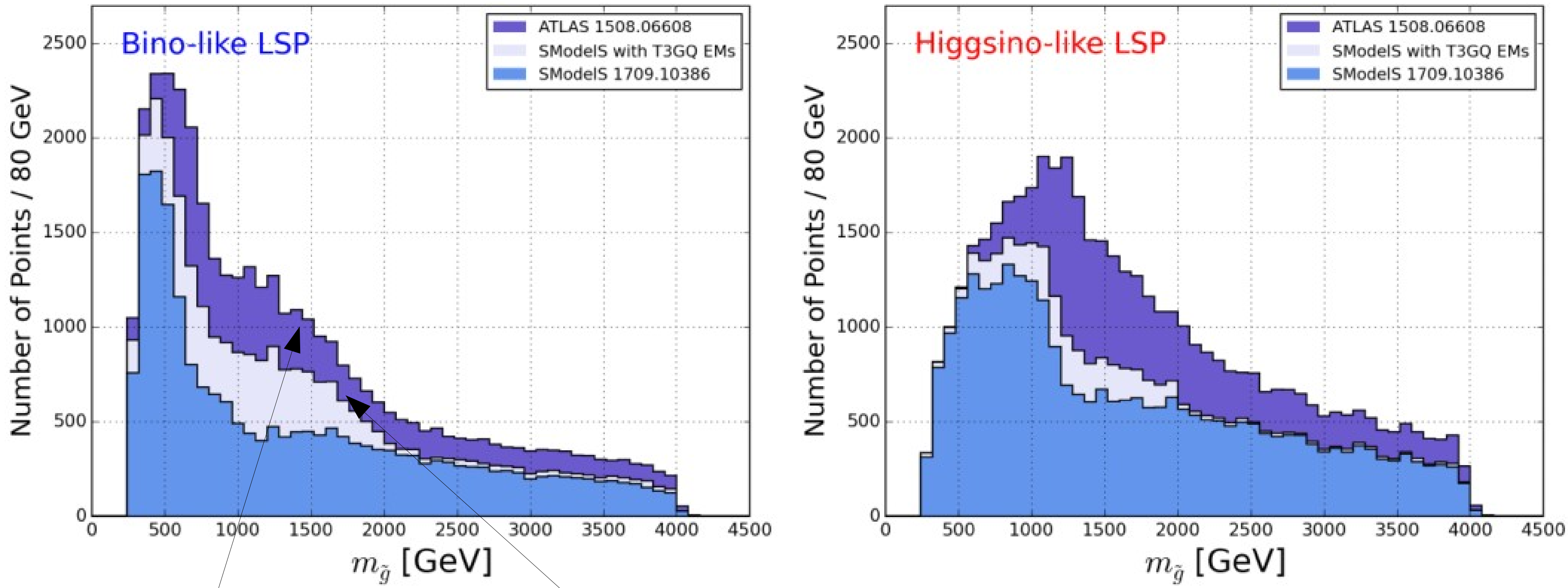


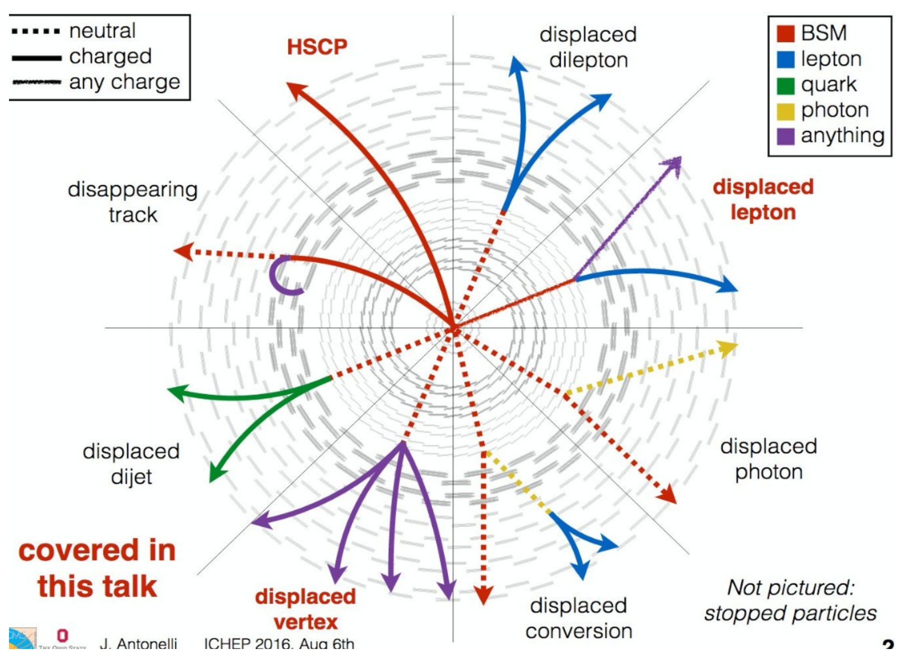

number of points that the ATLAS result could exclude

number of points our simplified models results of these ATLAS analyses exclude (**about 70 – 75%**)

# Ongoing development:

## SModelS v2.0: displaced signatures

We are currently in the validating phase of v2.0. We expect to be able to release v2.0 by this summer. Largest improvement: treatment of all kinds of displaced signatures. We hope to release before this summer.




J. Antonelli

# Longer term plans for SModelS ≥ v2.1

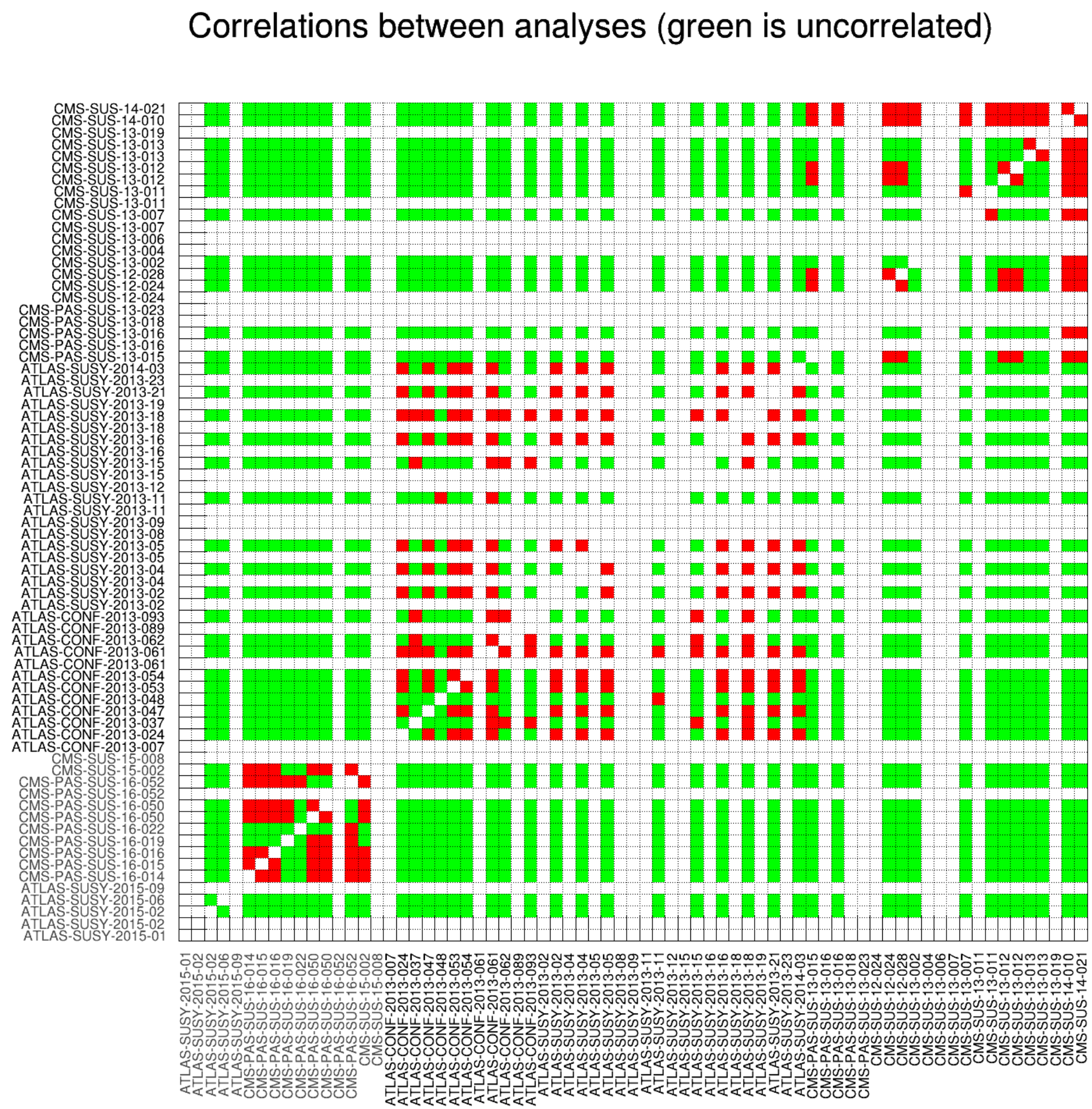
**Our long term plans include:**

- **Extension of experimental symmetries beyond $Z_2$ symmetries: dark matter models, resonances, ….**
  Even in v2.0.x we will still be limited to models with $Z_2$ symmetries and two-branch structures (our SUSY legacy)
- Use simple **Multi-Layer Perceptrons** to speed up the lookup and interpolation of the experimental results
- allow also e.g. **UFO files** to describe the input model
- **Joint likelihoods for combining analyses**
  We can trace which analysis results are approximately uncorrelated, and which arent. Exploiting this information we can compute joint likelihoods for combinations of uncorrelated analyses. A combinatorial optimizer can find the best (expected) combination.
- **Description of positive results with simplified models**
  So far we are only treating exclusions – negative results

# Combination of analyses

**Joint likelihoods for combining analyses**

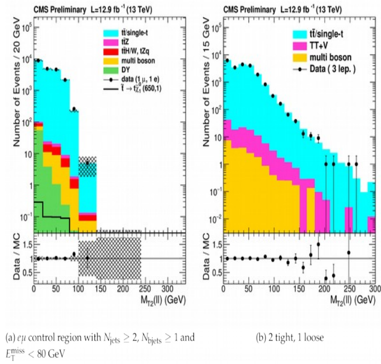
many pairs of analyses can be treated as approximately uncorrelated (the green blocks, think e.g. of a 8 TeV ATLAS result and a 13 TeV CMS result)

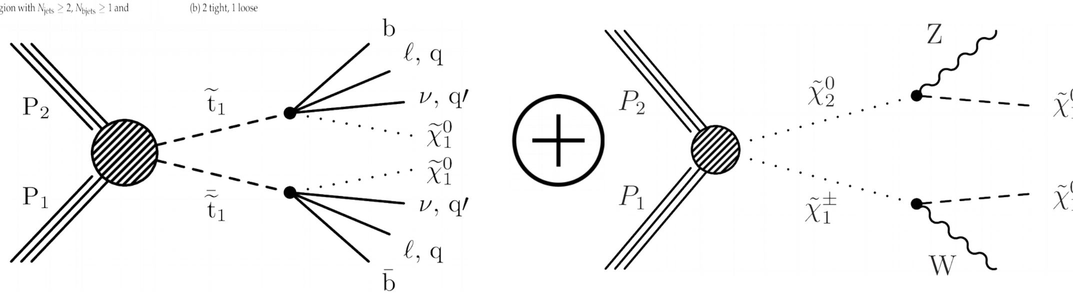


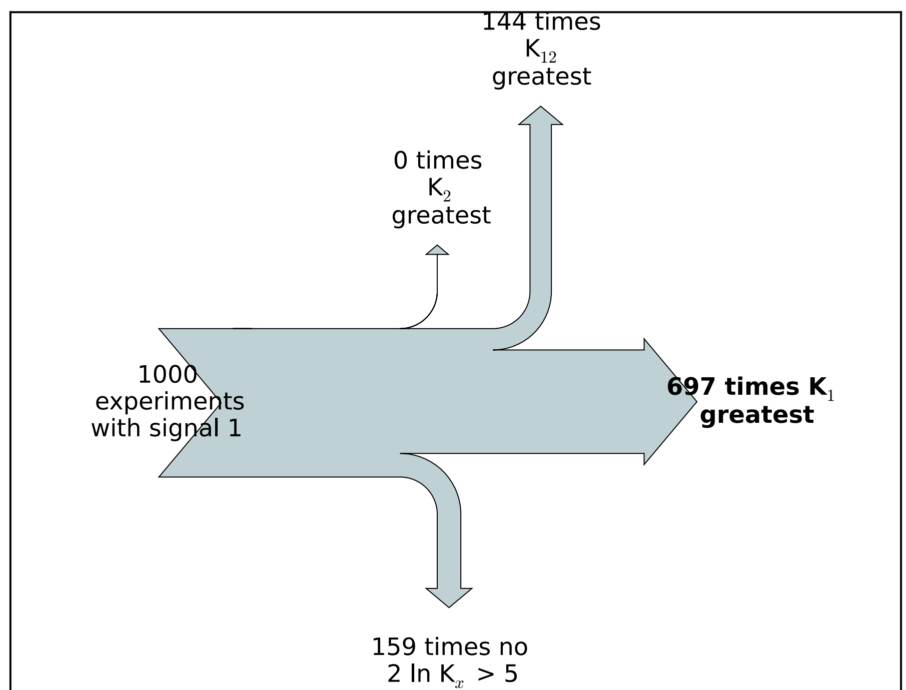
# Description of positive results with simplified models

So far we are only treating exclusions – negative results. In the long run, we also want to be able to describe positive results with simplified models in SModelS. Positive results with simplified models are more tricky because the problem of model selection becomes non-trivial. We intend to solve model selection with Bayes factors, parameter inference with likelihood maximization.

Example on the right: mockup study, two candidate models (above), and the model selection outcome, when model #1 is "right".



http://smodels.github.io

**pip3 install –user smodels**

Thank you!