How, Then, Will We Find BSM Physics?

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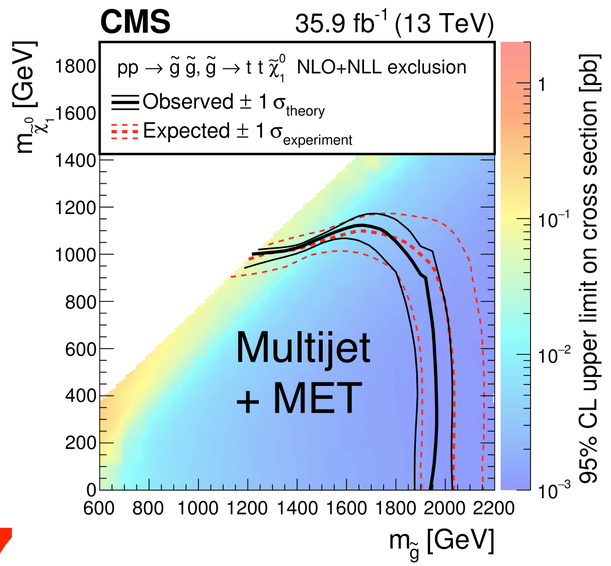
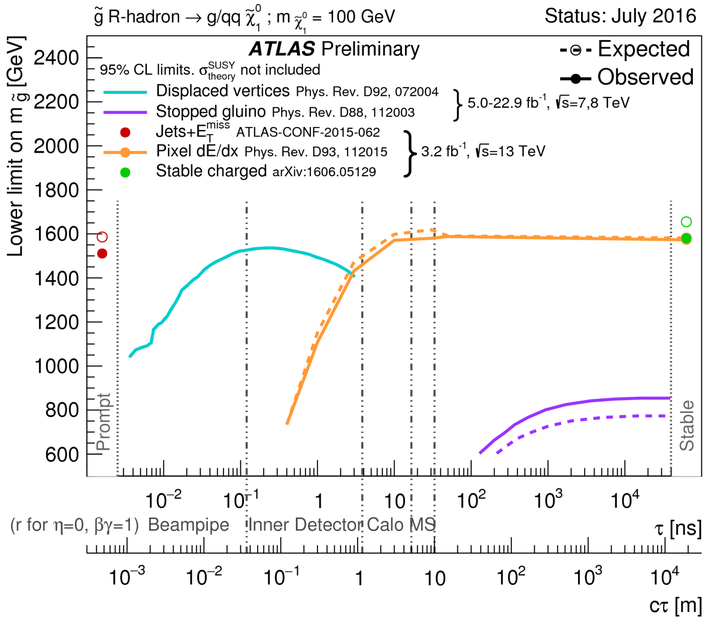
Experimental Thoughts

- What's new?
  - LHC 13 TeV era
    - ~140 fb^{-1} so far, very partially analyzed, most results still ~35 fb^{-1}
      - 3 ab^{-1} for full LHC run…
  - Higgs exists, light
    - Naturalness: Increased focus on new physics closely linked to top, W, Z, i.e. producing top, W, Z …
    - … and Higgs
  - Strong limits in place, many 10 x m_H (or more)
    - Natural to ask: did we miss it?

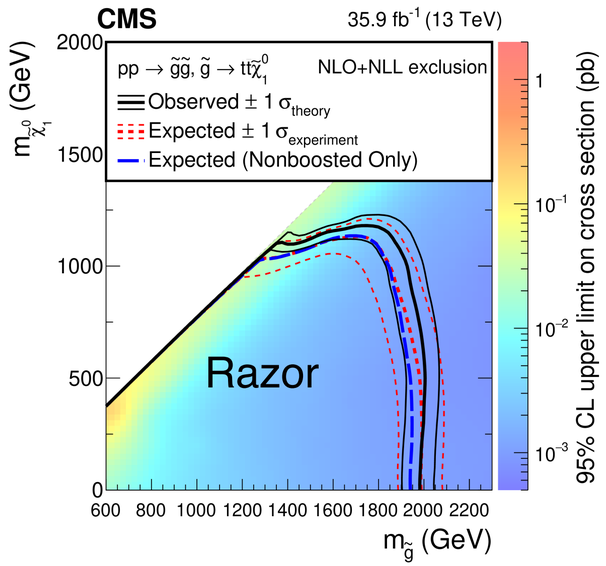
Some Limits “With Dark Matter”

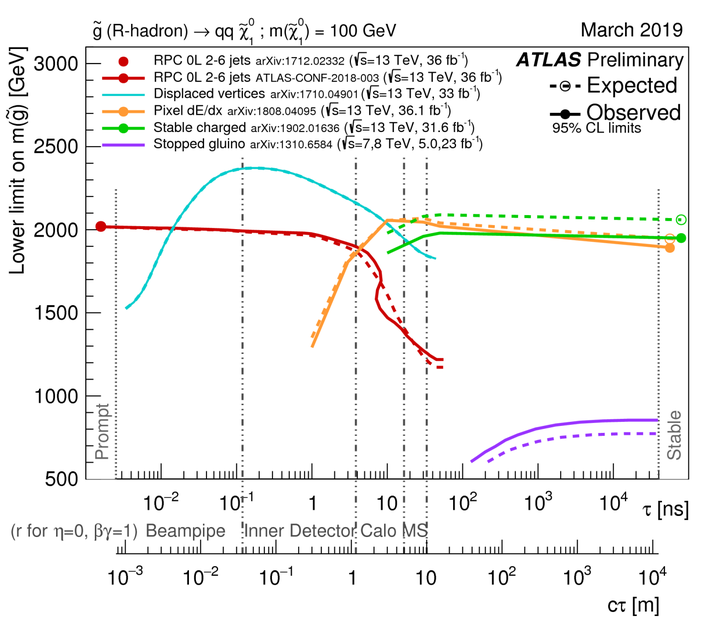
2017



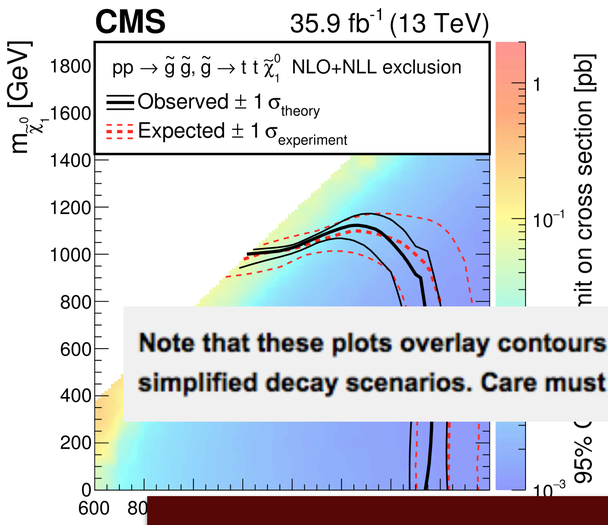


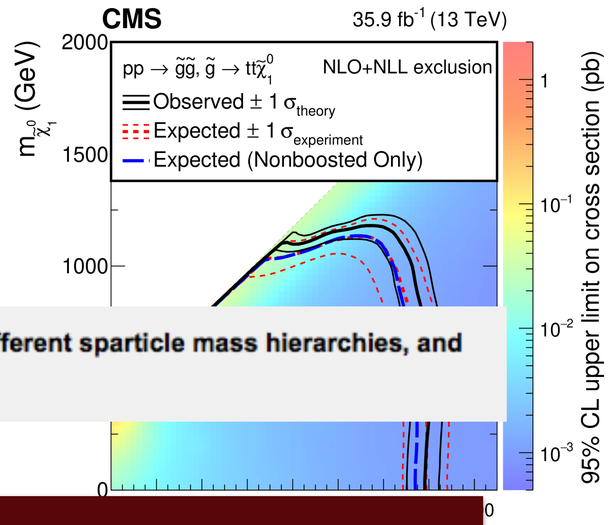
2019





Some Limits "With Dark Matter"



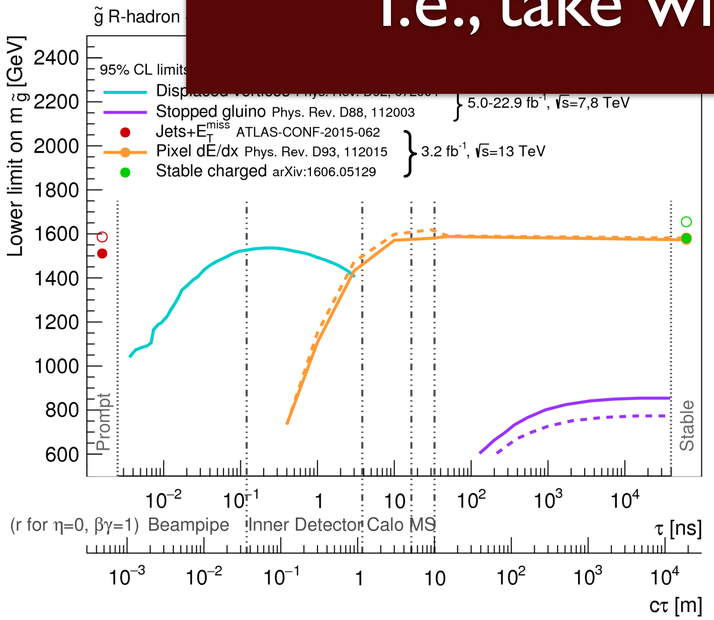


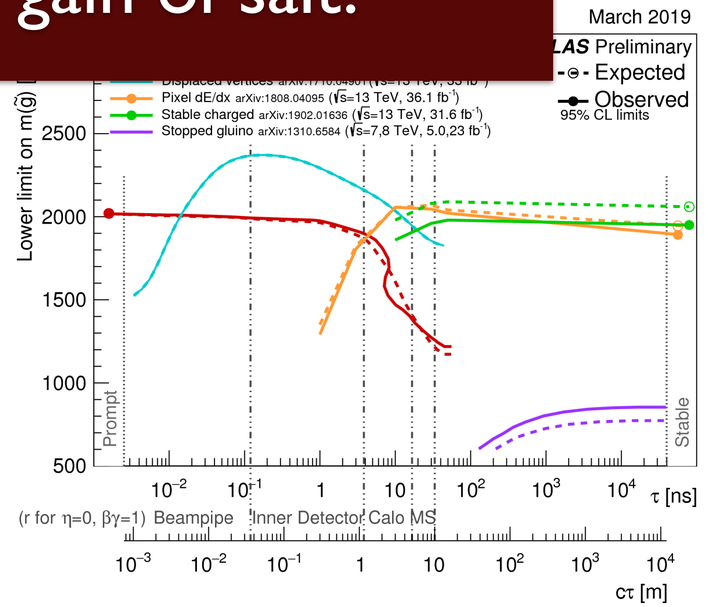
Note that these plots overlay contours belonging to different stop decay channels, different sparticle mass hierarchies, and simplified decay scenarios. Care must be taken when interpreting them.

2017

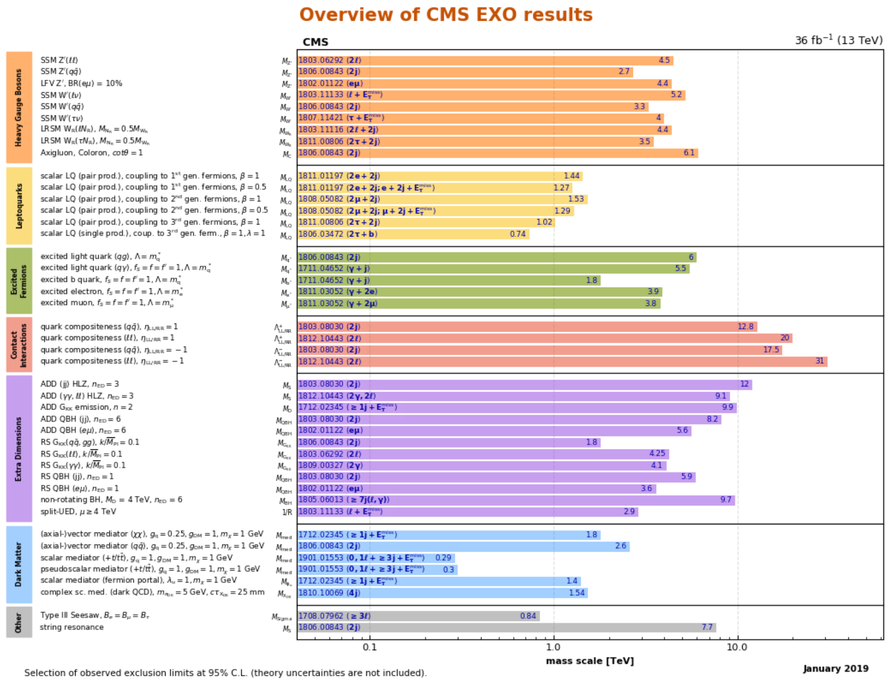
2019

I.e., take with appropriate gain of salt!

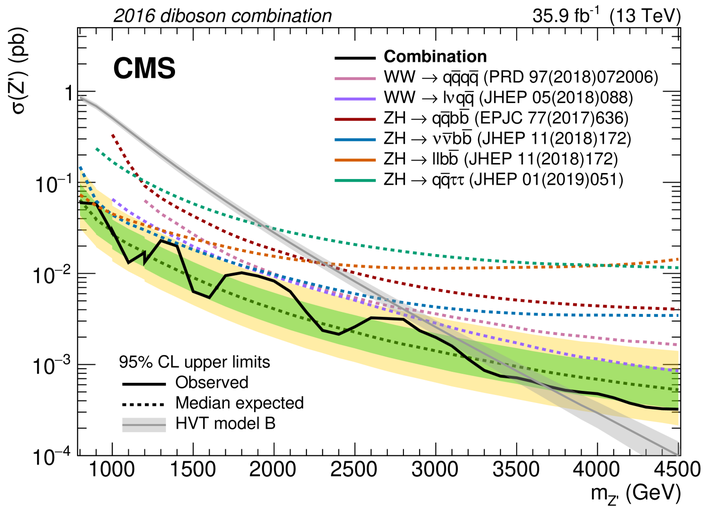


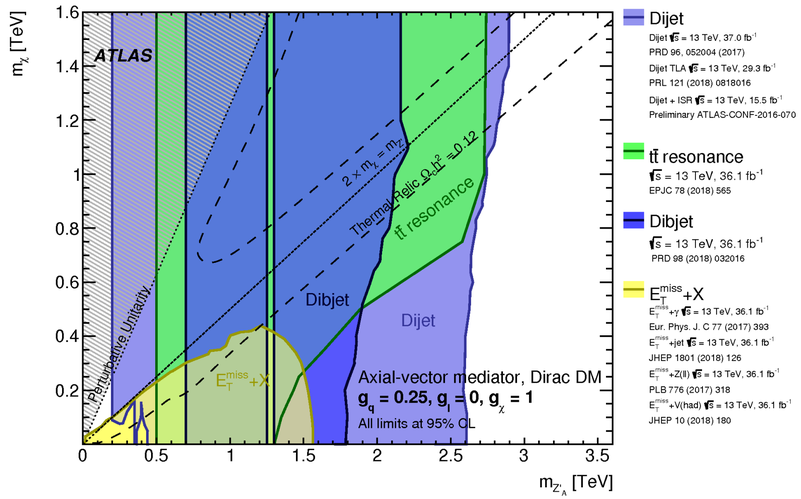


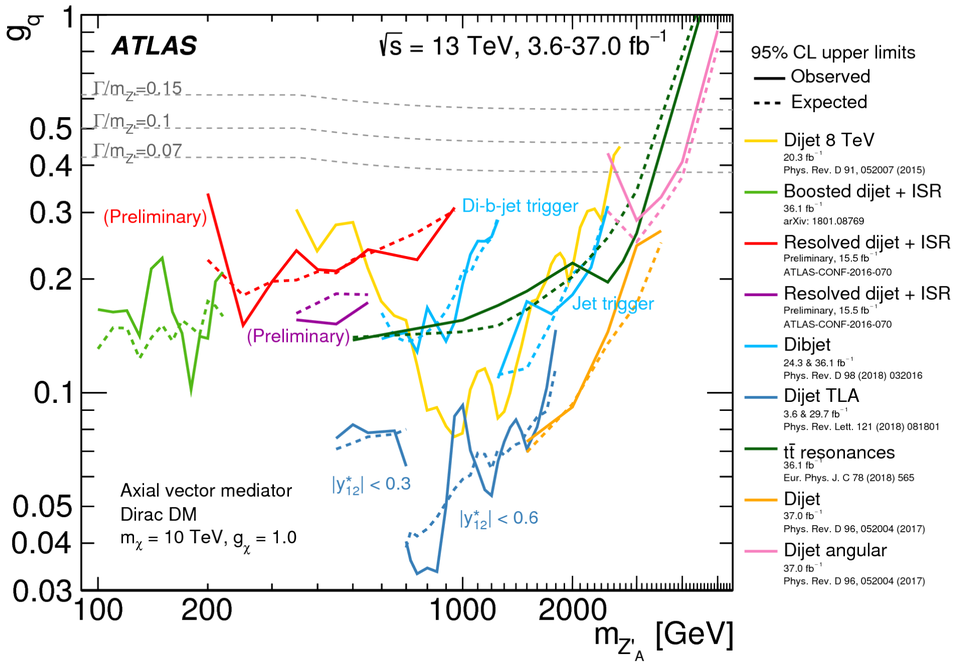
Current Limits: Non-SUSY



Selection of observed exclusion limits at 95% C.L. (theory uncertainties are not included).





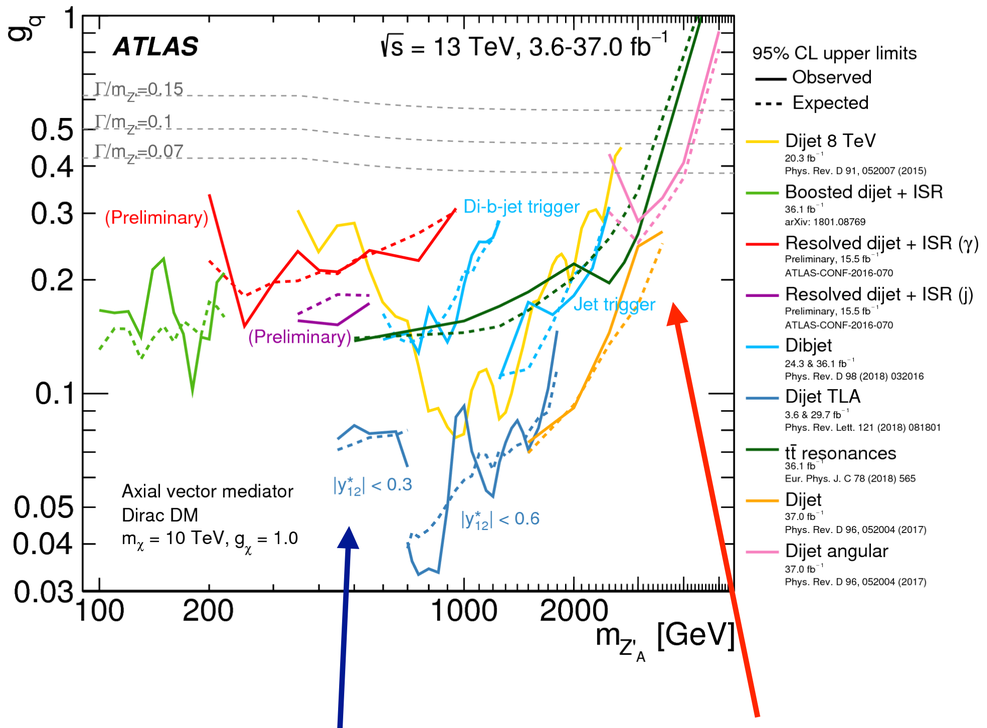


Still Only Limits..

- No new physics in LHC reach?
  - Remains unlikely (in my view)
- At edge of today's (or tomorrow's) reach?
  - Then just a matter of time
- More complex than we currently think of?
  - W, Z, top, Higgs discoveries often cited as examples
  - But nobody predicted QCD (which we still struggle to understand)
    - Discoveries that need new paradigms usually data-driven
  - New physics at ~200 GeV may be hard to find, in particular if jetty signature

Top-Down vs Bottom-Up

- Theory: model ⟹ signatures
- Experiment: signature ⟹ discovery (or limit)
  - Resonant?
    - Many many things done, still gaps though…
  - Dark matter in the decay chains? (SUSY)
    - Novel signatures from complex dark matter?
  - (Semi-)long-lived?
  - **Are we missing something?**
    - How much can new tools help us in the few 100 GeV region?
    - Are we even looking at this the right way? (QCD…)



Experimenters at Les Houches

- Profit from many discussions with theorists - learn
- Help theorists understand what is (not) possible
  - Particularly important to fill “gaps”
    - What can we trigger on?
    - How soft a lepton can we tag with low background?
    - The realities of hadronic calorimetry
    - Experimental uncertainties
    - …
  - Can we get around these limitations by being smart?

- Collaborate (with theorists) on studying sensitivity to new approaches/signatures
  - Enough theorists here to generate 1000(s) years of experimental work
    - Be selective
  - Remember that publication in proceedings (important!) requires the use of generic tools, e.g. Delphes (which are also faster)
    - Approval of MC studies using ATLAS/CMS tools will be difficult
    - Similarly, do not discuss non-approved work/results

Organizationally

- Conveners try to facilitate interactions
  - “Group” people with similar interests
    - Subgroups will coalesce in next few days
  - Wiki!
- … but encourage participation well beyond primary topic of interest during stay in Les Houches
  - Exchange of ideas, brainstorming are key to making this productive
    - Ideas developed in one context often valuable in another
- No talks scheduled; favor black-board discussions (leave time to get some work started though)
  - There are projectors for plots…
  - Work towards write-ups continues after our stay