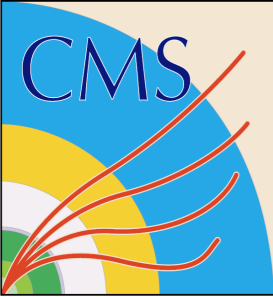


# Presentation of search results in CMS

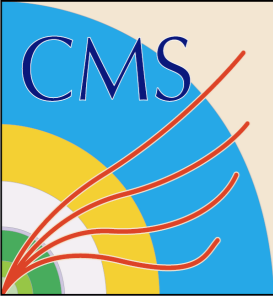
Alex Tapper



# Overview

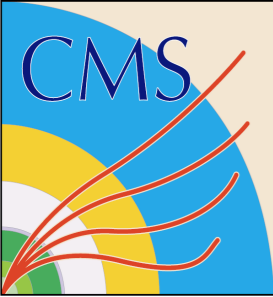
- Experimental results
- Model dependent interpretations
- Model independent interpretations
- Practical issues

Find all results at: <https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResults>



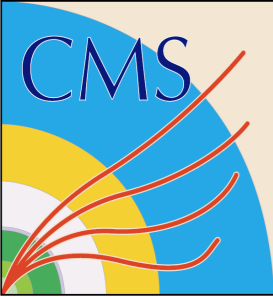
# Experimental results

- Where appropriate CMS papers contain a table showing the cumulative number of events passing each stage of the selection and the number of background events expected (either from MC, some other estimate or both)
- Final numbers are provided with statistical and systematic errors separated
- Where complicated variables are used in the selection we provide code (on public wiki page) for the variable
  - Examples are  $\alpha_T$  and the Razor variables



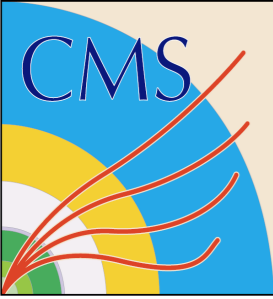
# Experimental results

- Shape fits are more difficult to interpret easily than cut and count
  - Give data and background yields in each bin → done for  $\alpha_T$  and used in several (many) phenomenology papers
  - Also working on recipe to produce an approximate likelihood for the 2D fit used in the razor analysis
- Have also started to look into expressing search results in RIVET
  - Too soon for results



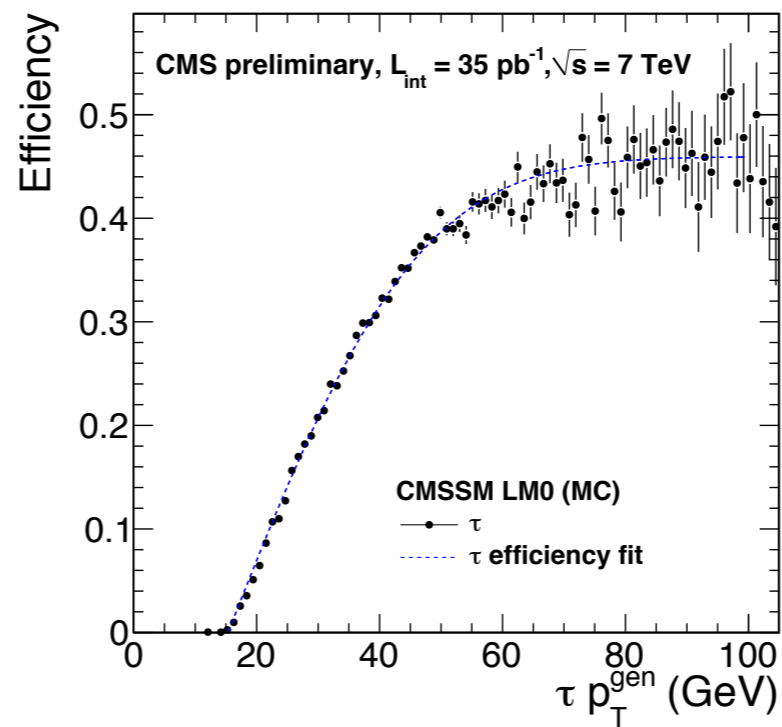
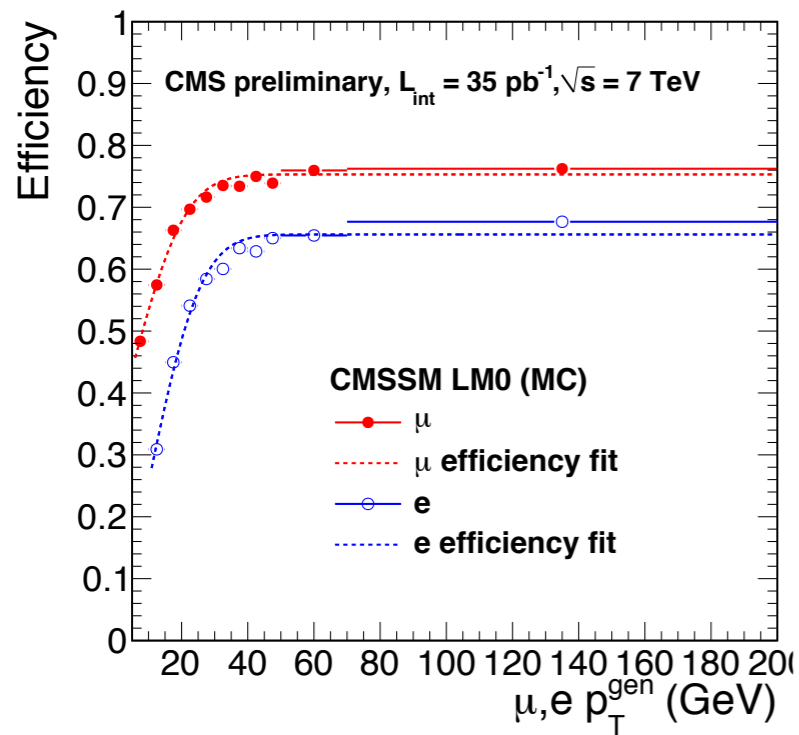
# Experimental results

- Extra information is provided (typically on public wiki pages) including extra distributions and histogram files in root format
- Aim to provide all numerical information in papers also in electronic format



# Experimental results

- Set of performance papers document CMS object performance
- Analysis efficiencies given in text, in bins where appropriate e.g. mass
- Also for in SUSY papers parameterisations given

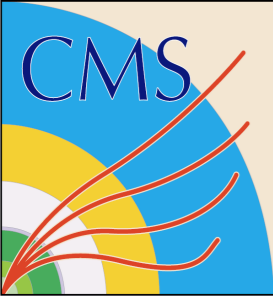


Parameterised  
efficiencies for  
 $e, \mu$  and  $\tau$

Resolutions  
for MET,  $H_{\text{T}}$

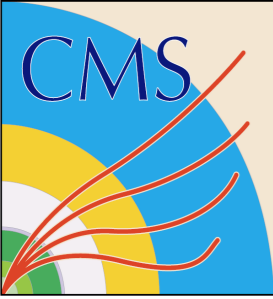
CMS-SUS-10-004

- So far in dilepton SUSY papers, but set to expand to other final states



# Model dependent interpretation

- Clearly we do not have sufficient resources to interpret our searches in all models
- Typically we choose one or two “standard” models for our papers

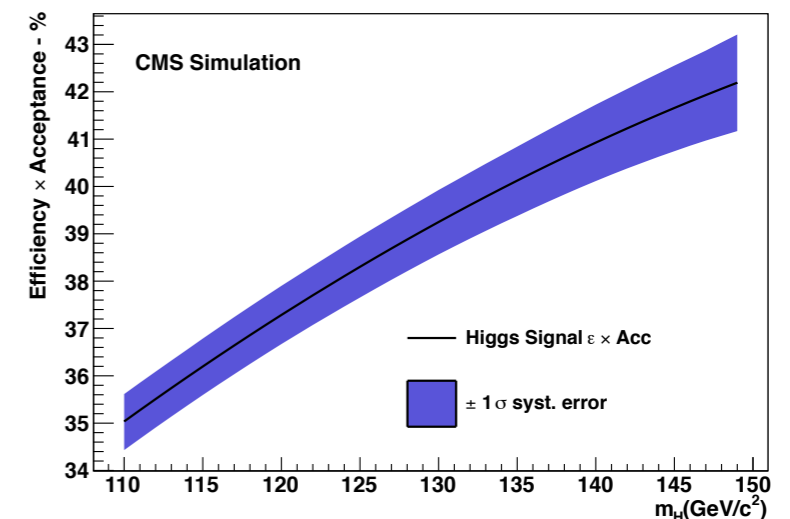
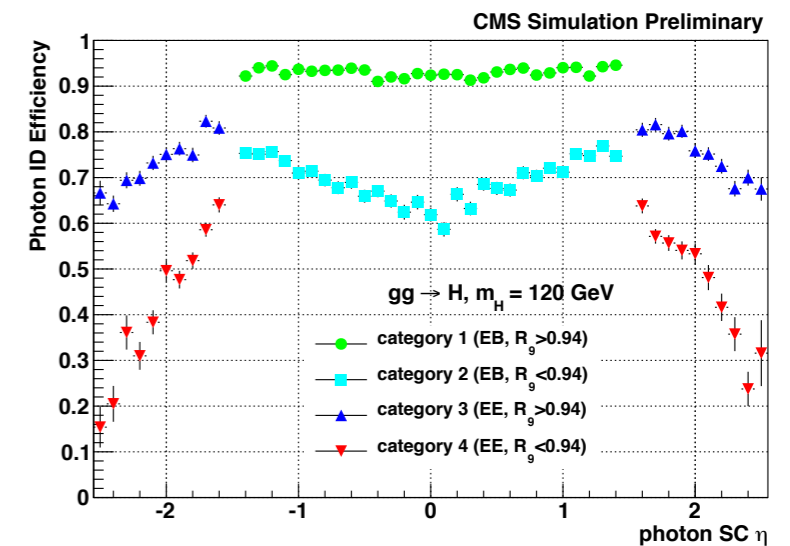
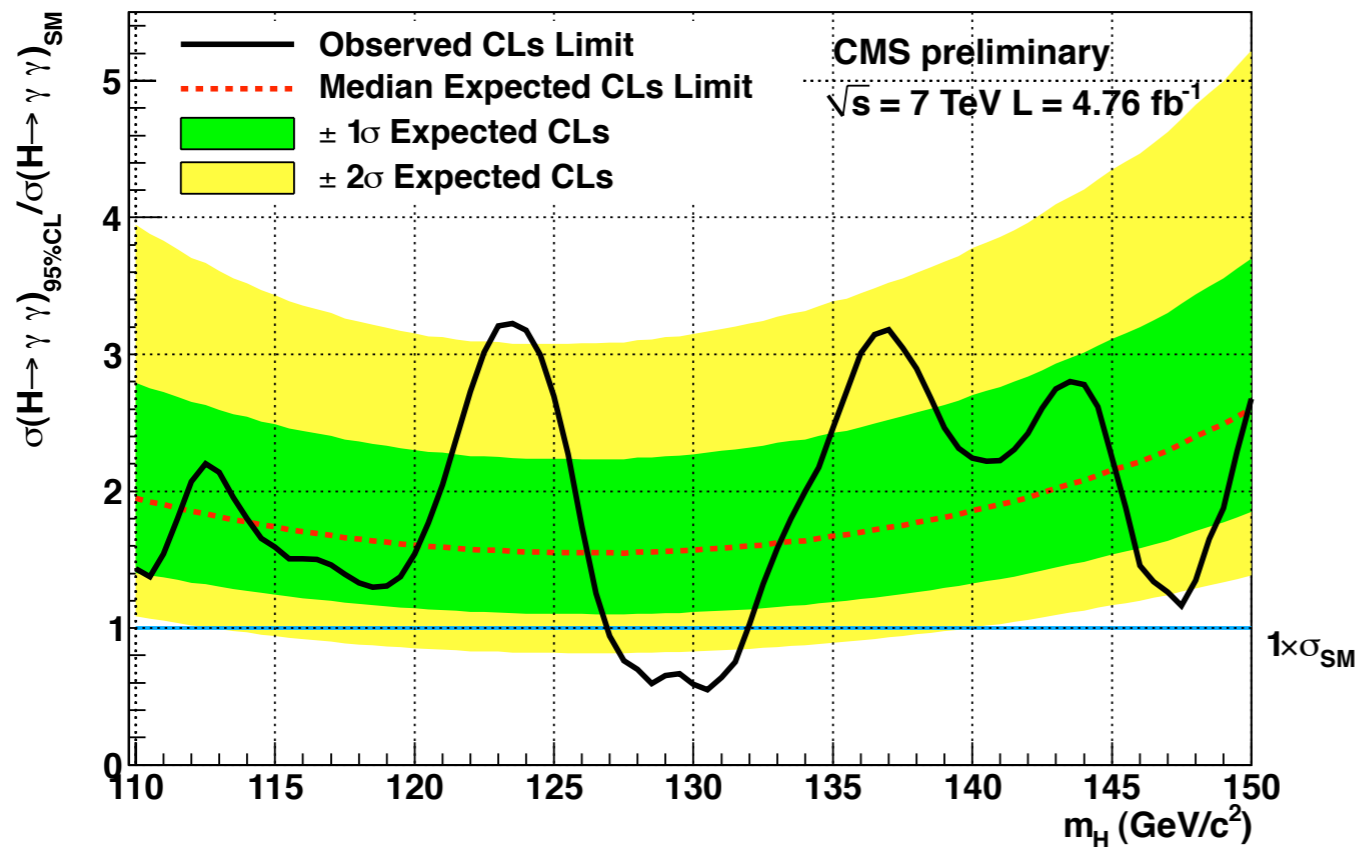


# Model dependent interpretation

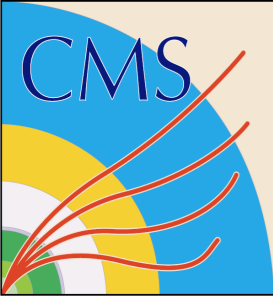
- For Higgs → The Standard Model

- Limits, efficiencies in each individual decay channel
- In future for each production channel too

CMS-HIG-11-030

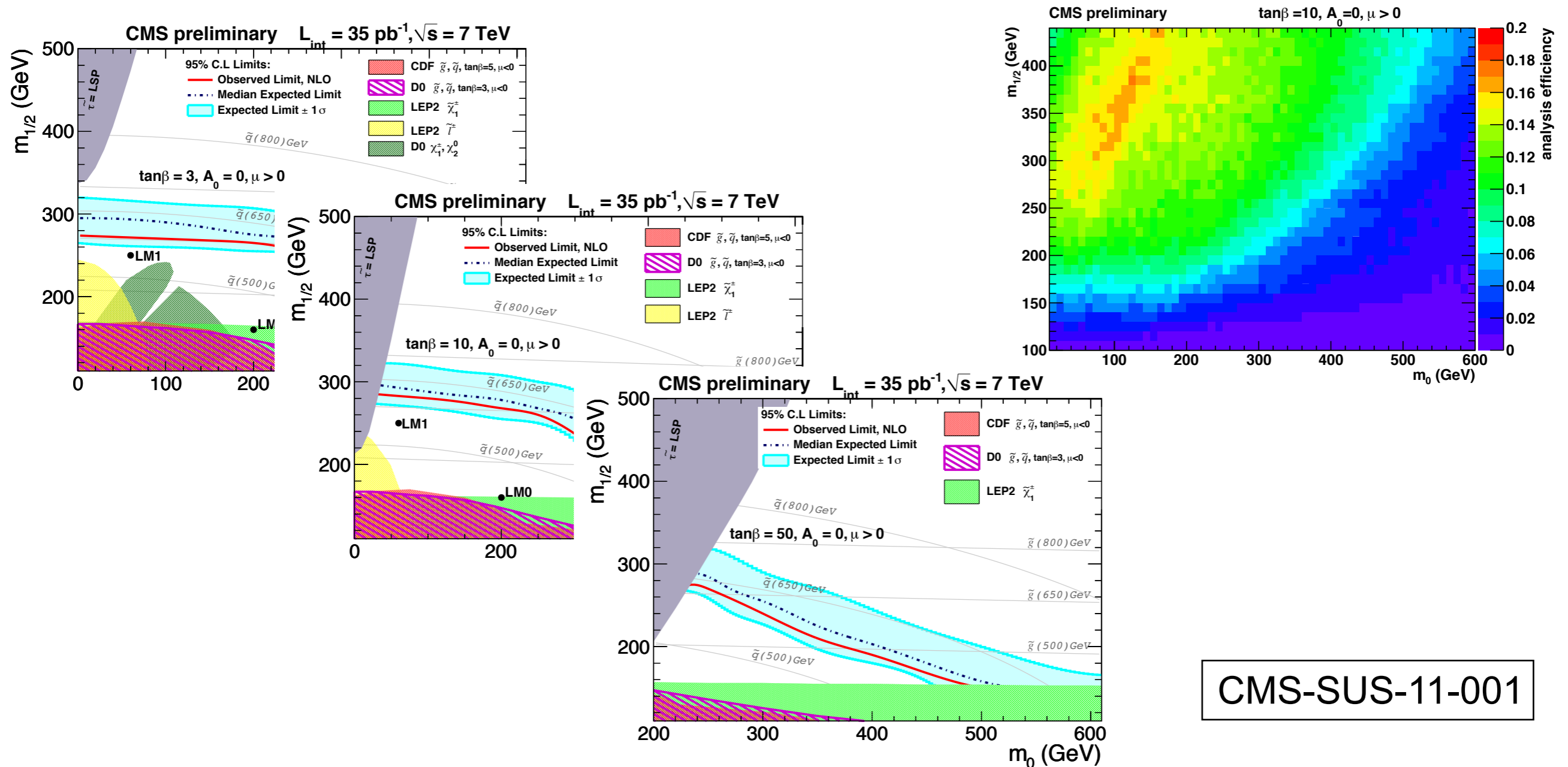




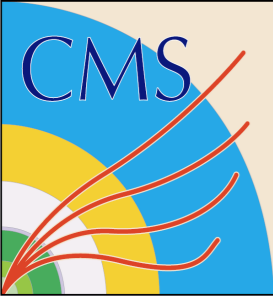


# Model dependent interpretation

- In SUSY typically the CMSSM
  - Limits, efficiencies, dependence on  $\tan\beta$ , efficiencies for sub-processes

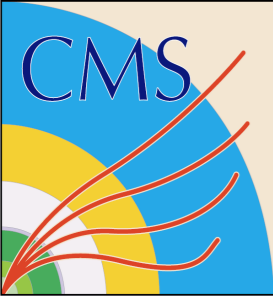


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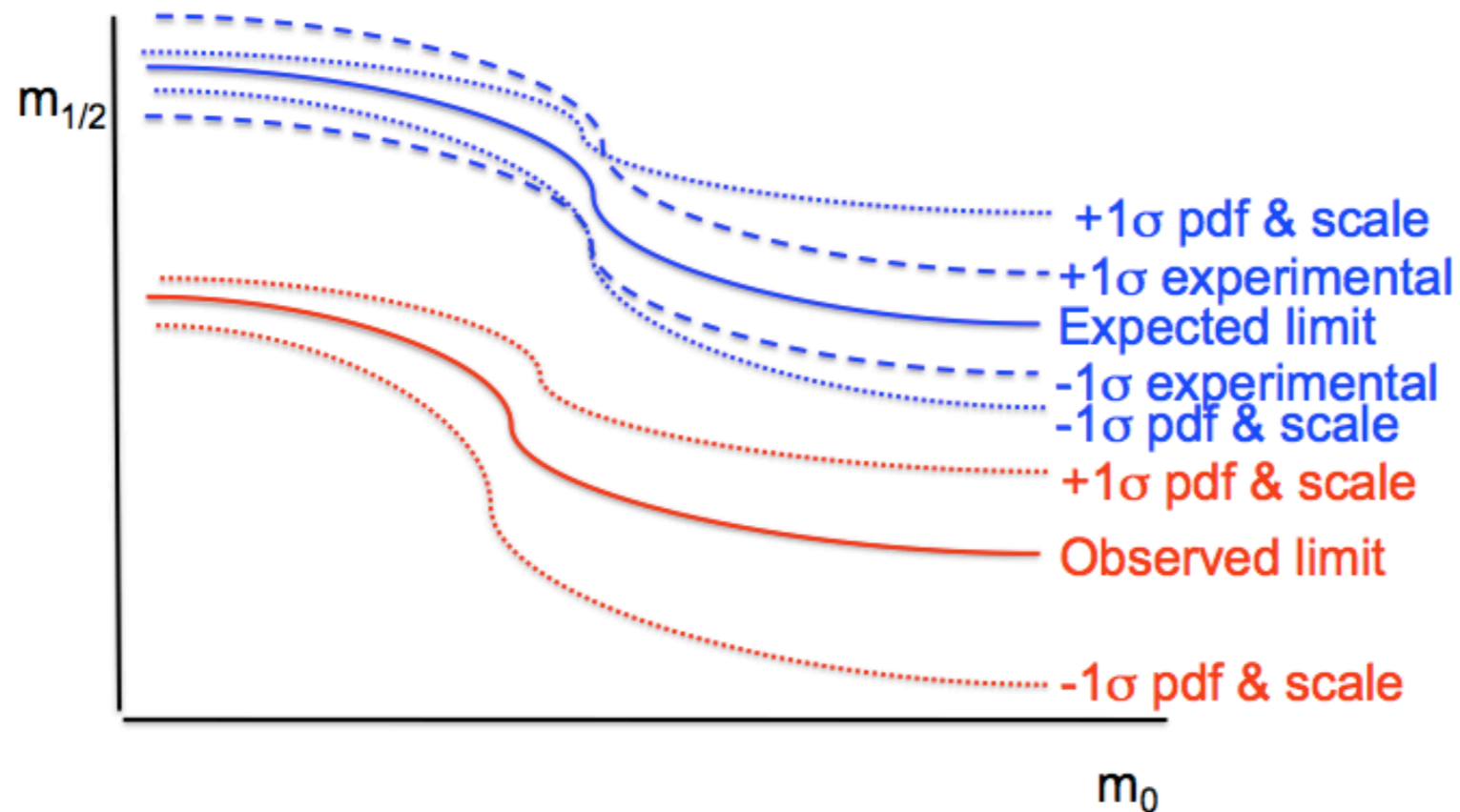
# Model dependent interpretation

- In Higgs world cross sections and procedures for theory uncertainties well agreed and published by working group
  - <https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CrossSections>
- In SUSY and EXO worlds less standardised up until now
  - Working group more recent
  - <http://web.physik.rwth-aachen.de/service/wiki/bin/view/Main/BSMCrossSectionWorkingGroup>
  - Before relied on *ad-hoc* agreements between ATLAS and CMS and used conventions from the Tevatron experiments

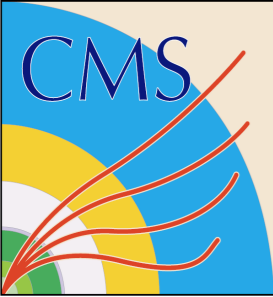


# Model dependent interpretation

- Have typically included theory uncertainties in SUSY limits
  - Most recent proposal to separate theory and experimental uncertainties
  - Under discussion by ATLAS and CMS working groups

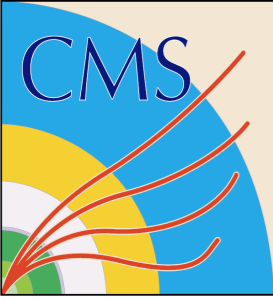


- **Expected** and **observed** limits calculated using **only experimental** uncertainties.
- Dashed  $\pm 1 \sigma$  experimental band calculated using **only experimental** uncertainties.
- Dotted theory bands obtained by recalculating limits after moving pdf and scale up/down by combined (quadrature)  $\pm 1 \sigma$  variation.



# Model independent interpretation

- Often given in particular in SUSY and EXO papers
  - Upper limits on numbers of events observed
  - Upper limits on  $\sigma \times BR$
- In some non-SM Higgs papers
  - For example in charged Higgs

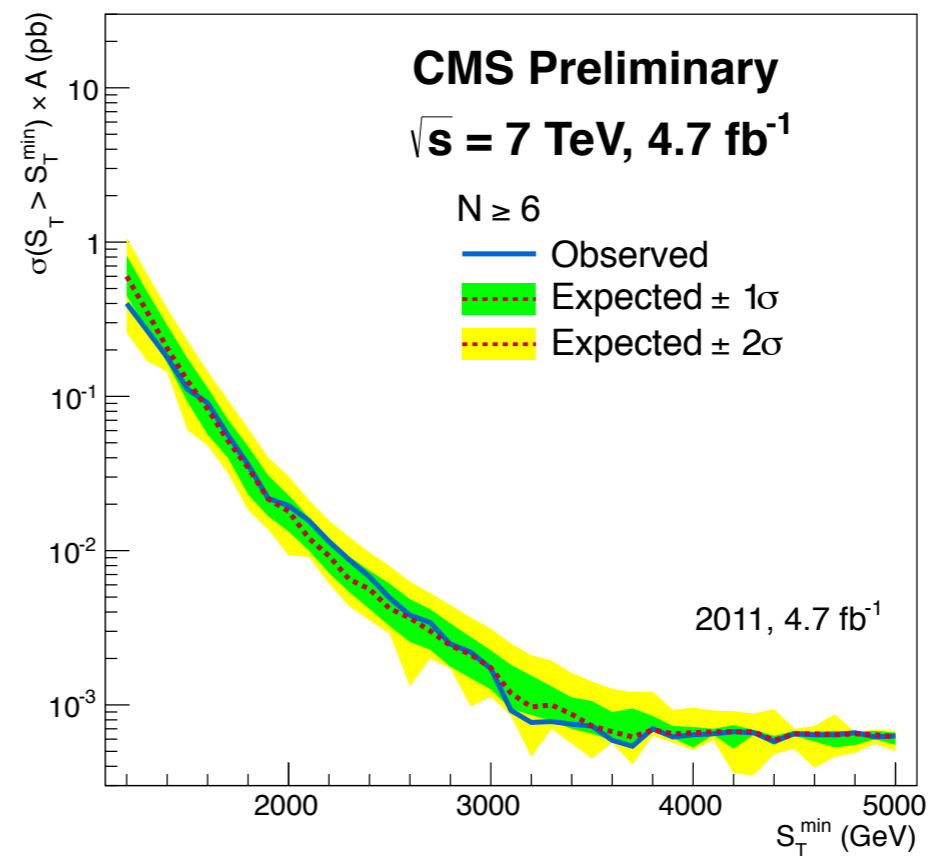
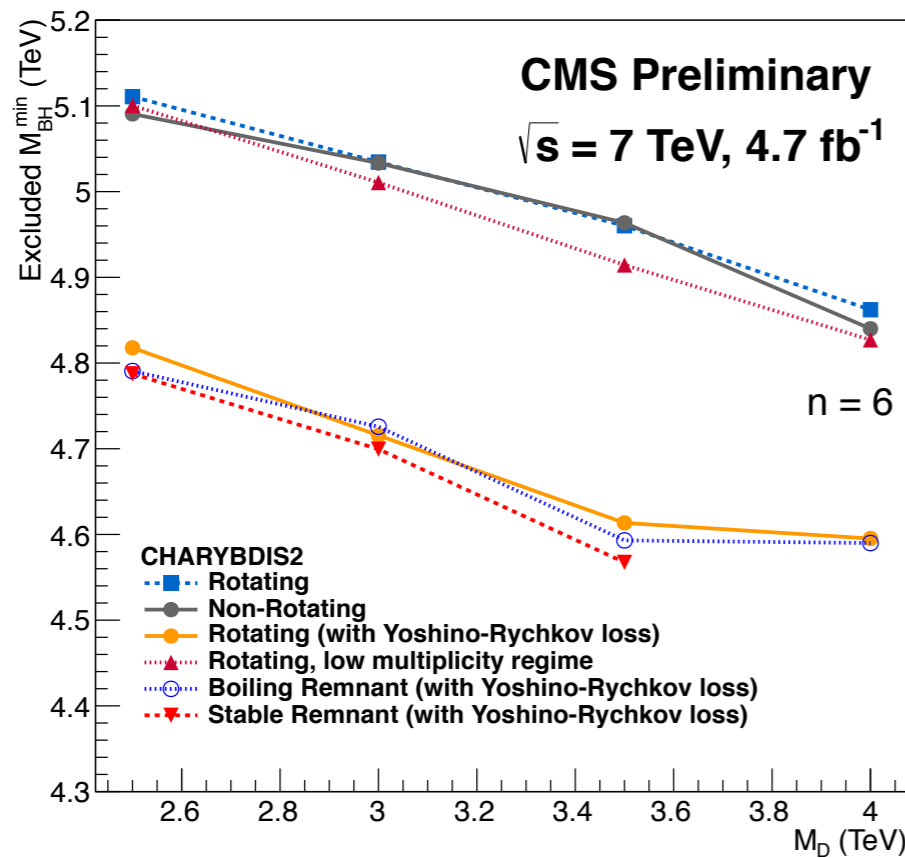


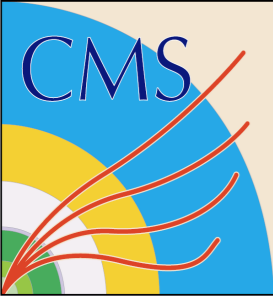
# Model independent interpretation

- Example from Black Hole search

CMS-EXO-11-071

- Give limits on theory parameter for several models
- Also give  $\sigma \times A$  as a function of the experimental quantity ( $S_T$ )  $\rightarrow$  apply to any model

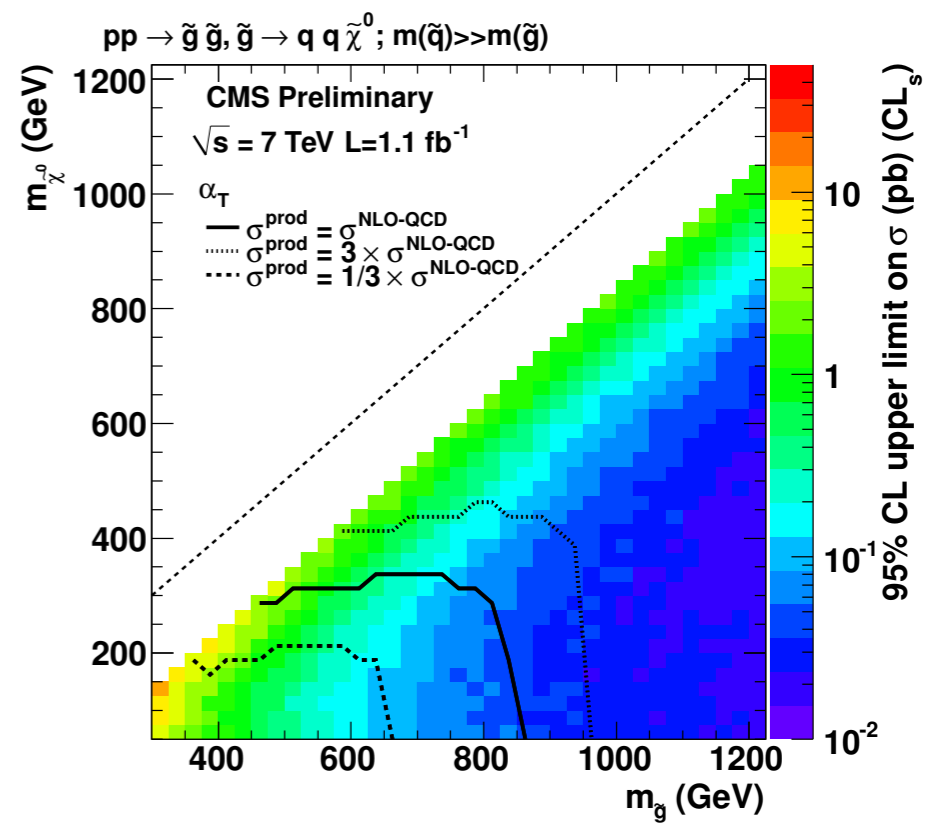
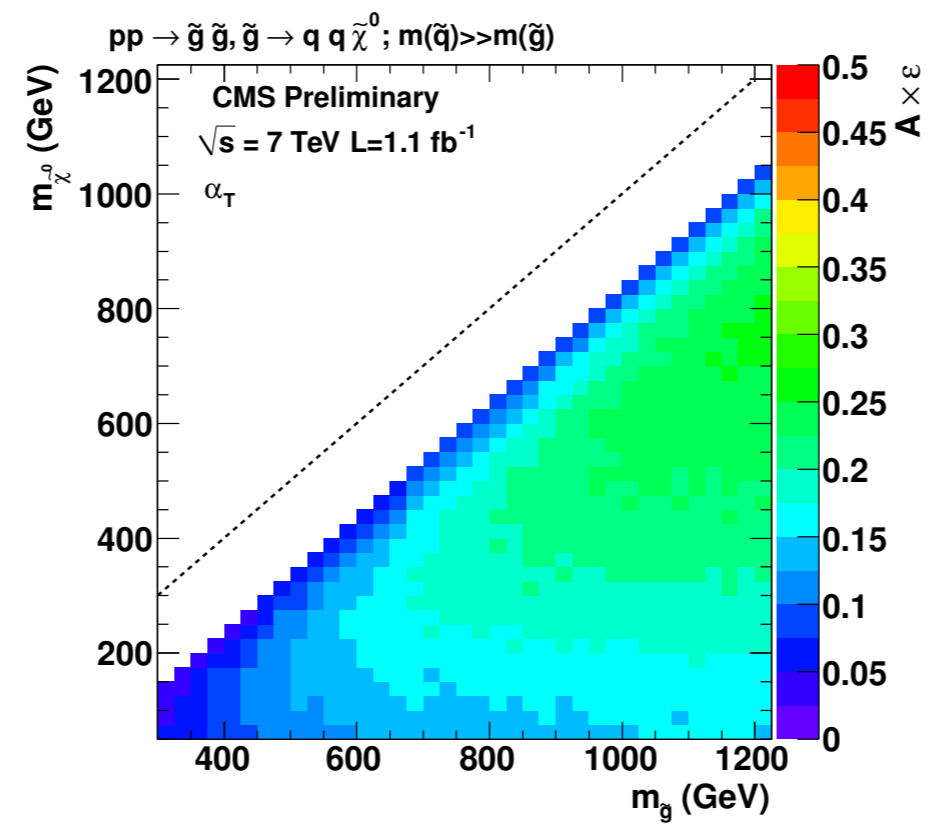
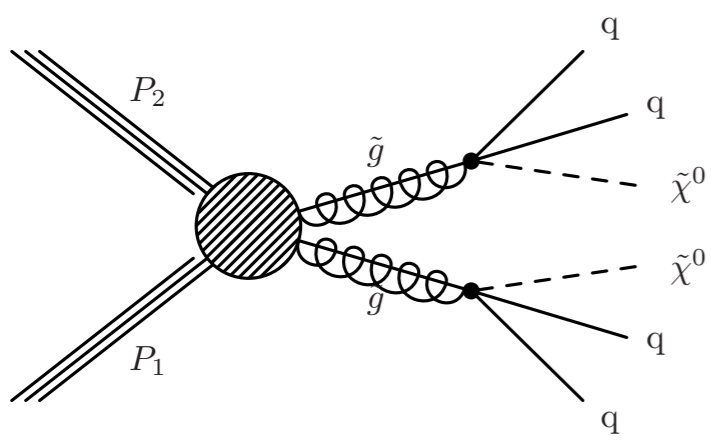


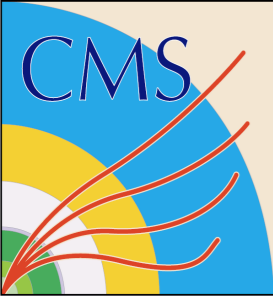


# Model independent interpretation

- Simplified Model Spectra pursued for SUSY searches
  - Efficiency\*acceptance, cross-section limit, experimental errors and theory errors, given for each point.

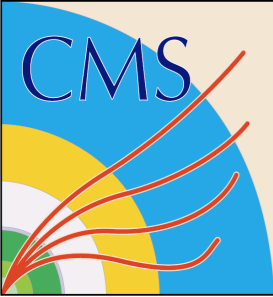
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# Practicalities

- Common SLHA files and (N)NLO cross sections available for Higgs and coming soon for SUSY and EXO
- For publications CMS policy is to store numerical information from paper in HEPDATA database
- For preliminary results numerical information available on public wiki pages



# Summary

- Aim to give all relevant experimental details in papers and electronically
- Interpret results in a small number of models in our papers
  - Give extensive information on interpretation in these models
- Give model-independent results
  - Upper limits on  $\sigma \times \text{BR}$ , Simplified Model Spectra interpretations
- Standardise theory input and agree conventions with ATLAS
- Aim to be more consistent across our papers in future