SUSY SEARCHES WITH THE CMS DETECTOR

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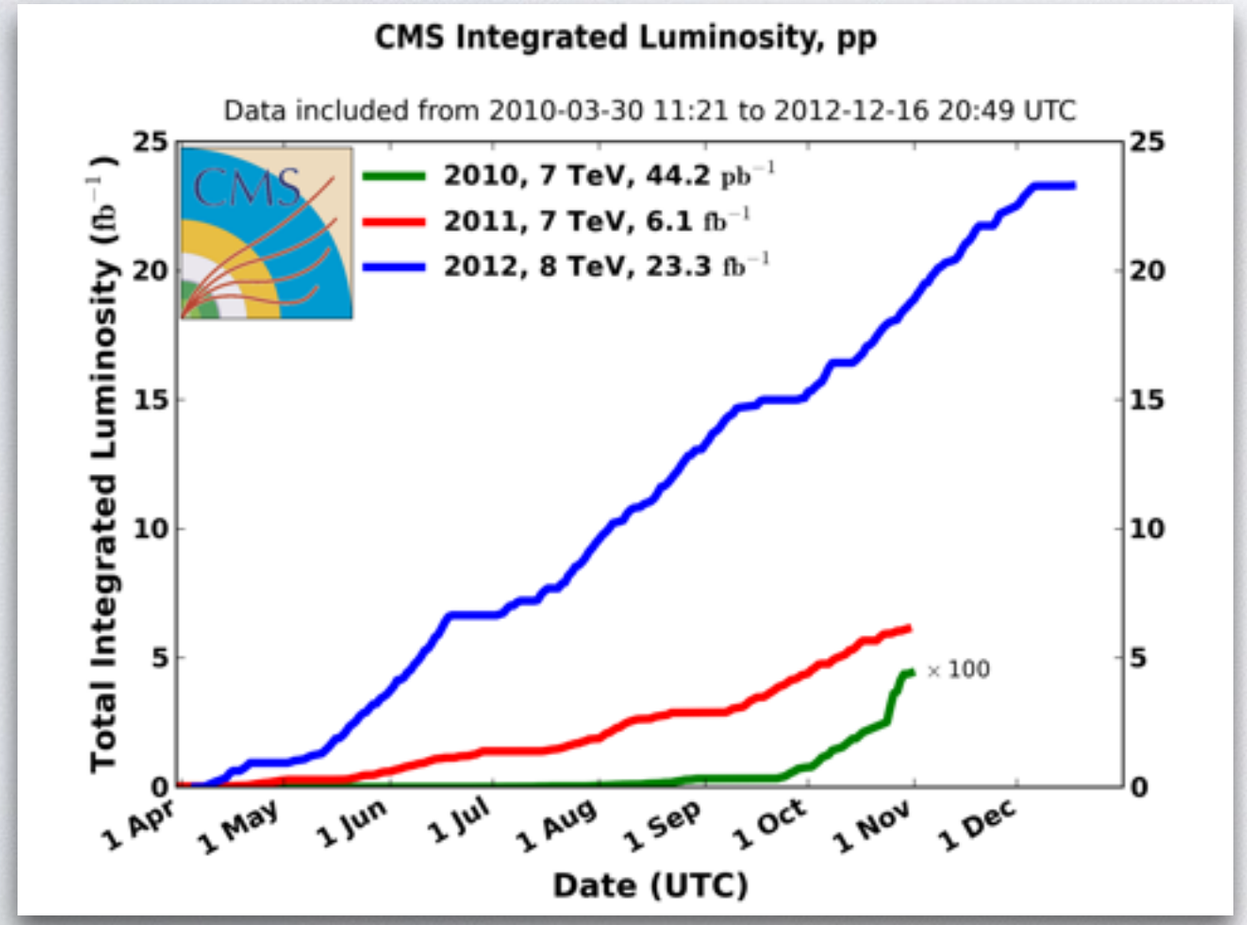
on behalf of the CMS collaboration

IFAE 2015 - Roma

LHC

Two main run periods

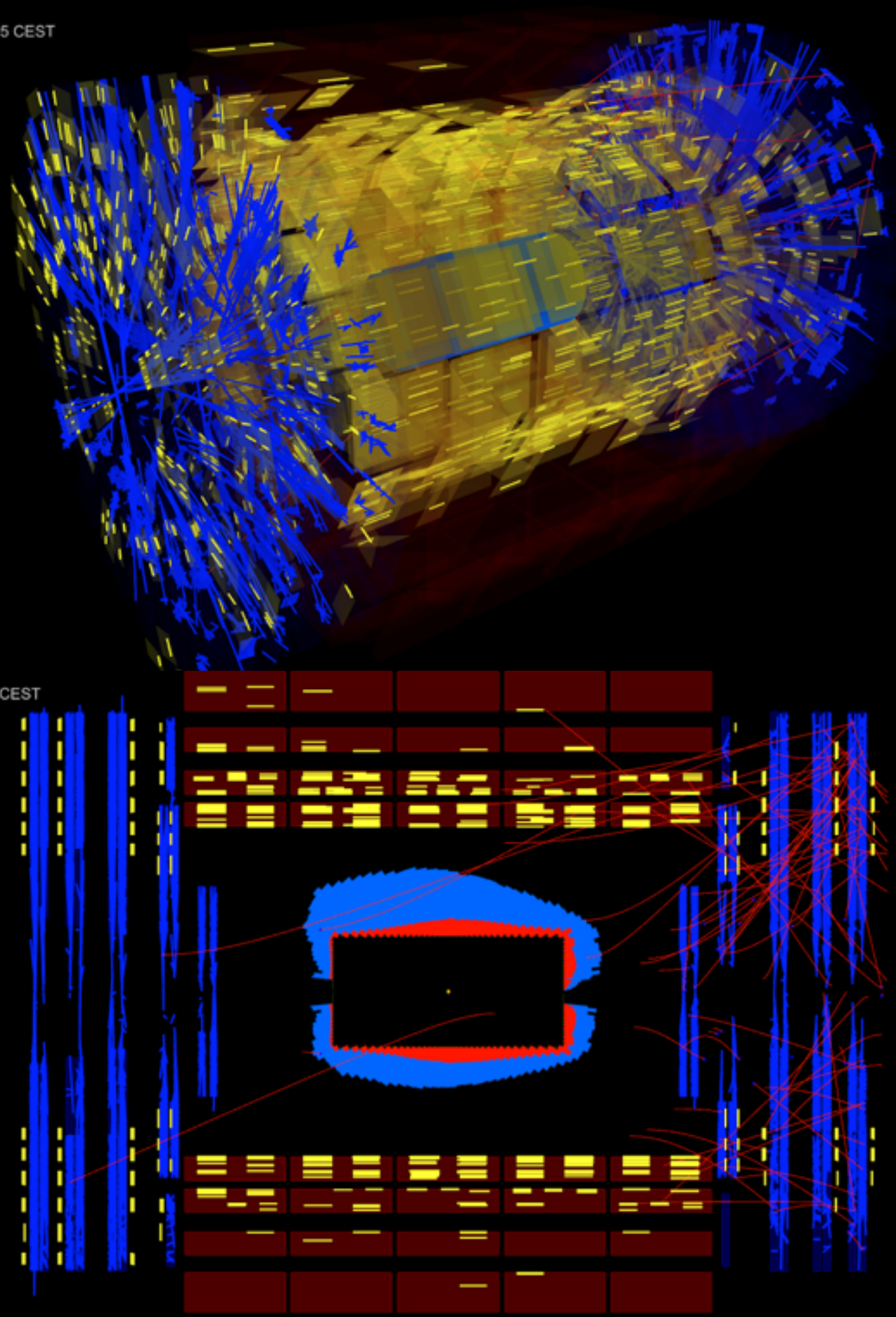
Results presented here are from the second at 8 TeV with 20 fb^{-1}



27 km proton proton collider

with 4 main experiments

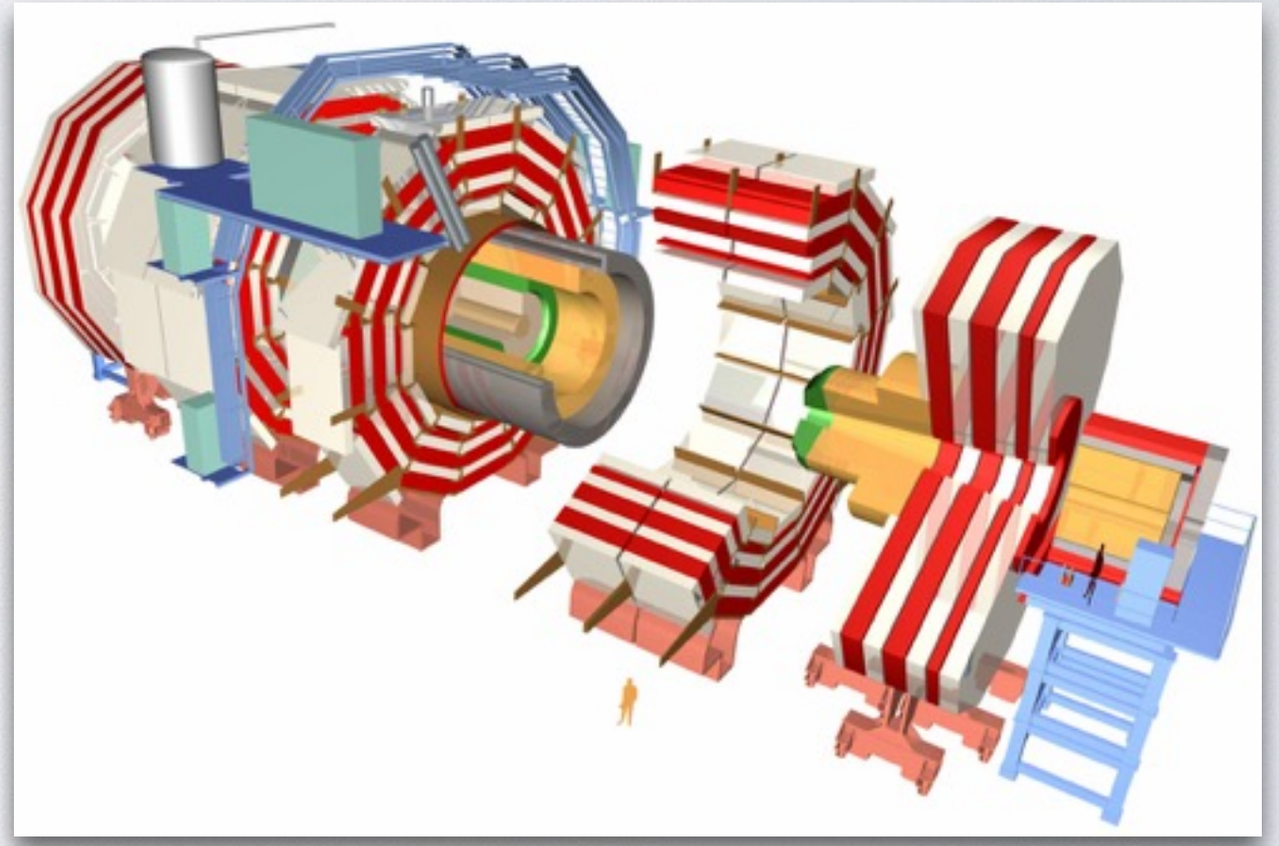
CMS Experiment at LHC, CERN
Data recorded: Sun Apr 5 10:29:07 2015 CEST
Run/Event: 239754 / 162
Lumi section: 89



CMS Experiment at LHC, CERN
Data recorded: Sun Apr 5 10:29:07 2015 CEST
Run/Event: 239754 / 162
Lumi section: 89

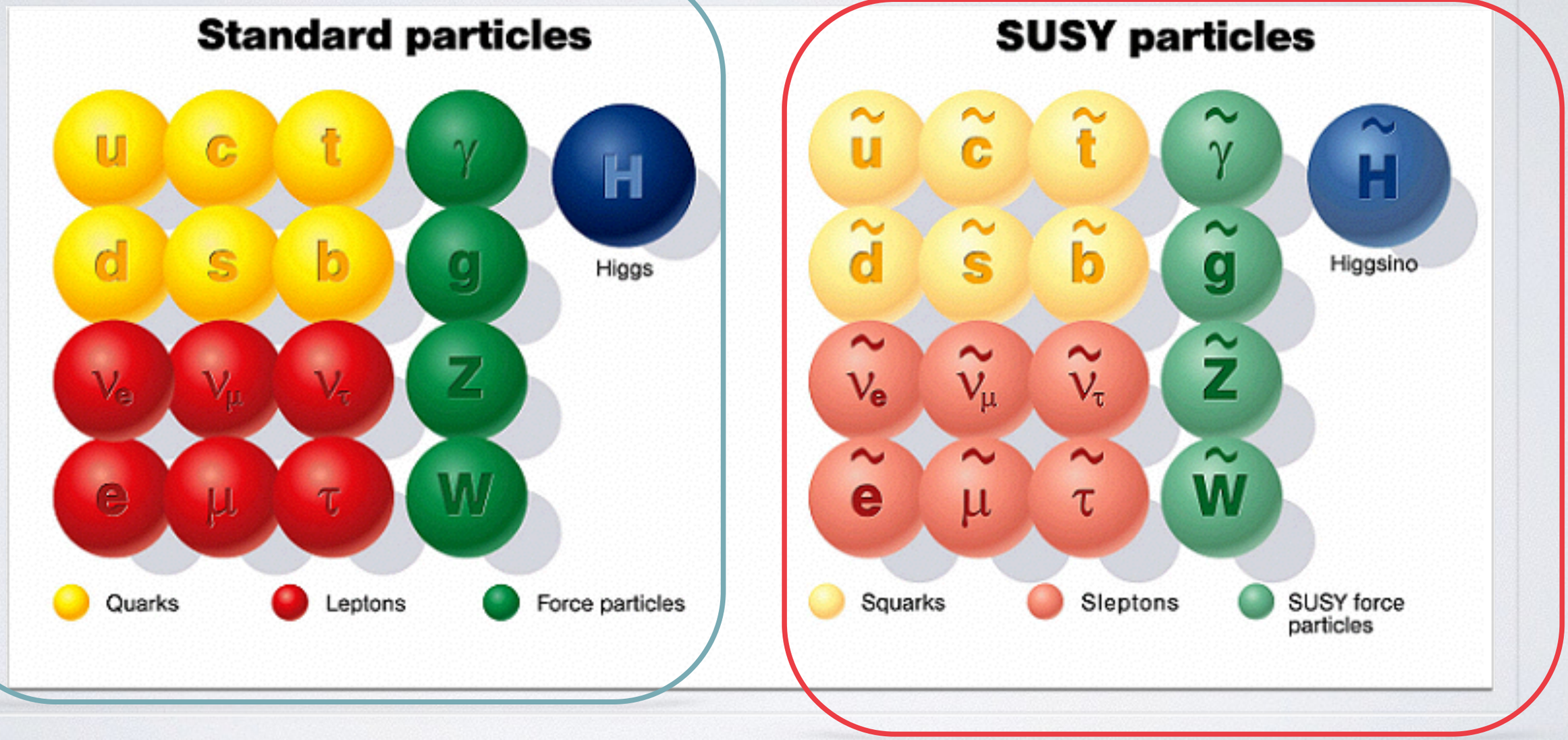
COMPACT MUON SOLENOID

- One of the two general purpose experiments at LHC
- Solenoidal magnetic field 3.8 T and return yoke
- Large Silicon Tracker with great momentum and particle resolution
- Scintillating crystal for ECal
- Sampling HCal (brass and scintillator)
- Redundant muon spectrometer in the iron return yoke



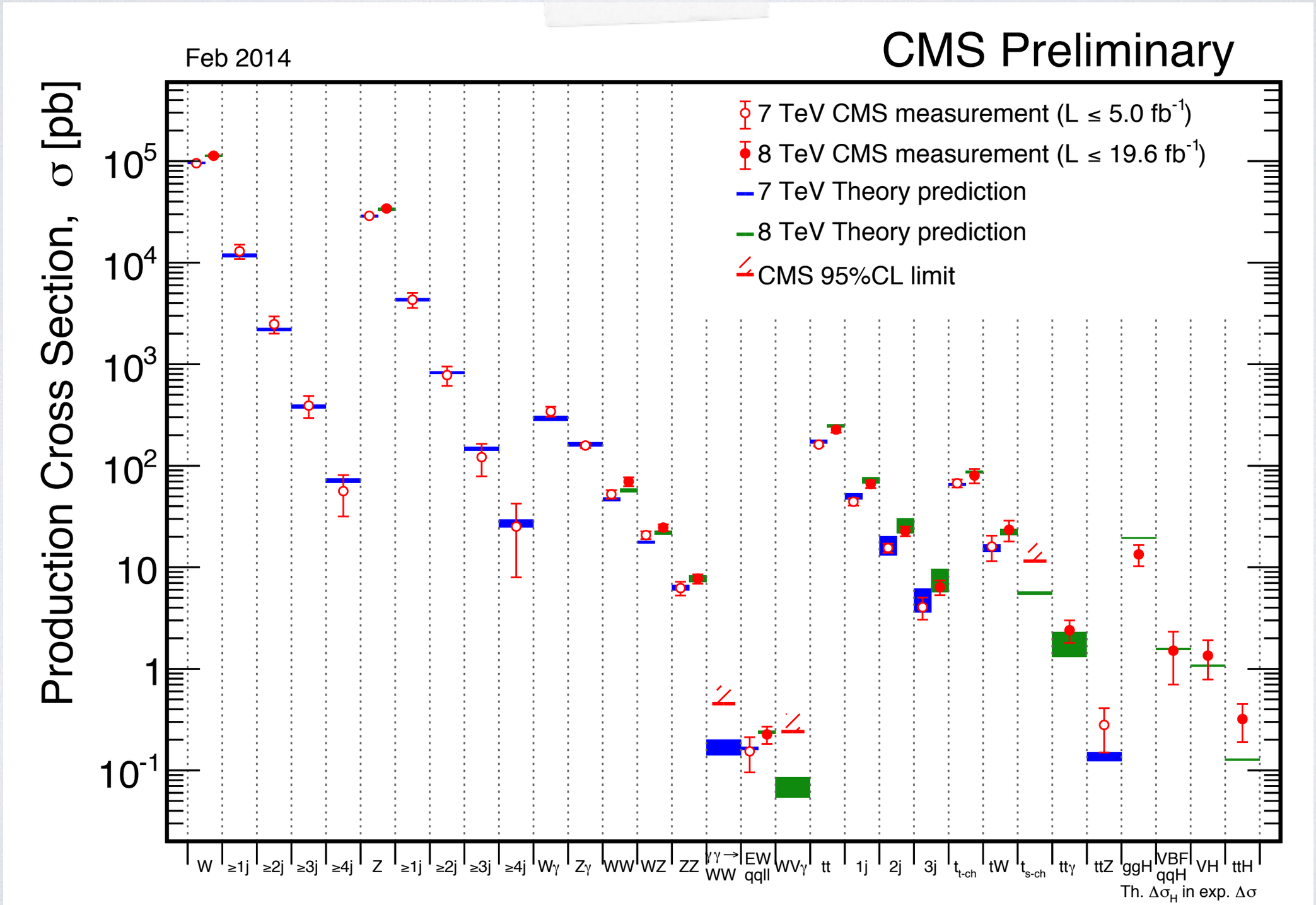
A SUCCESSFUL STORY

Half of it has been observed

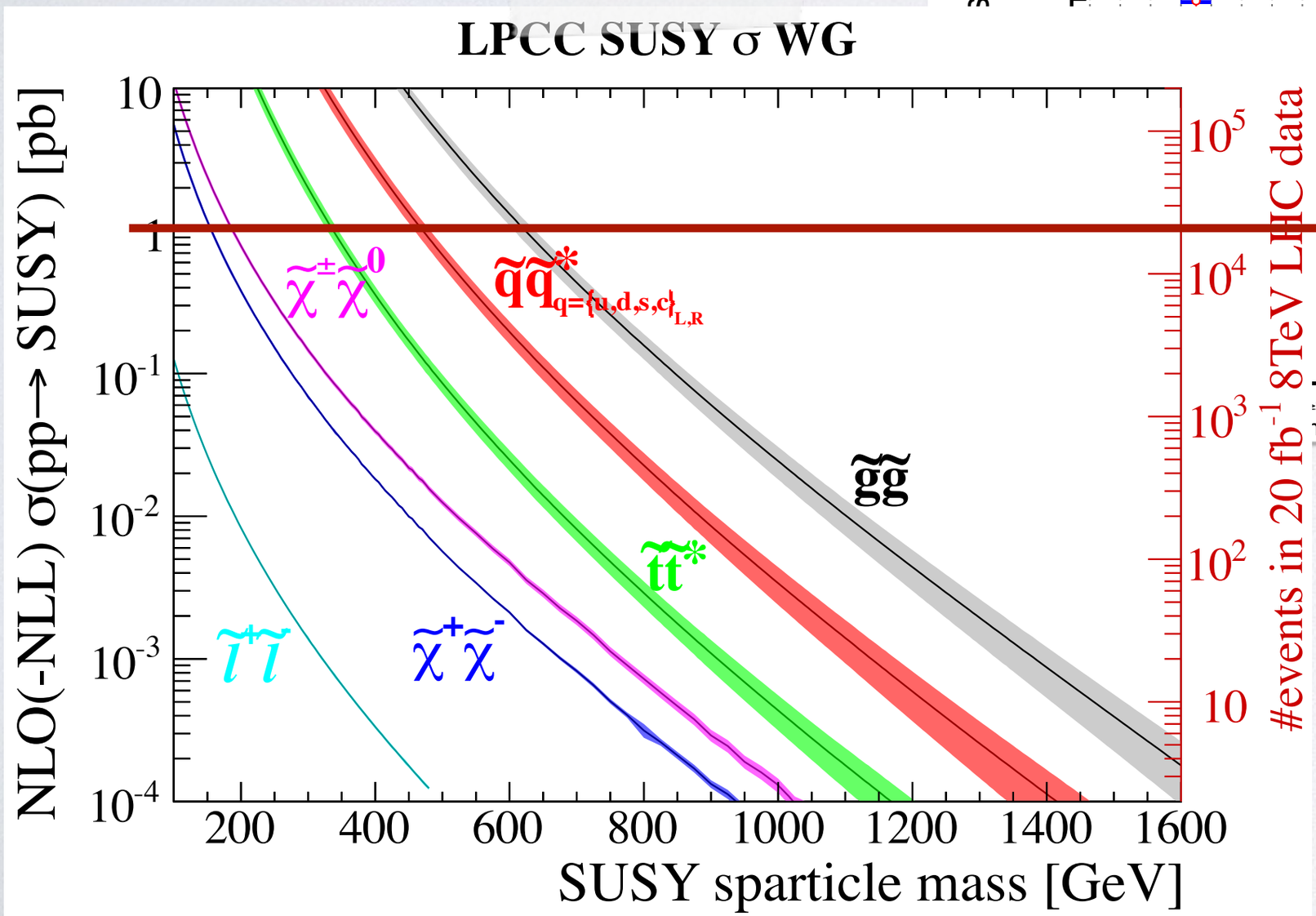


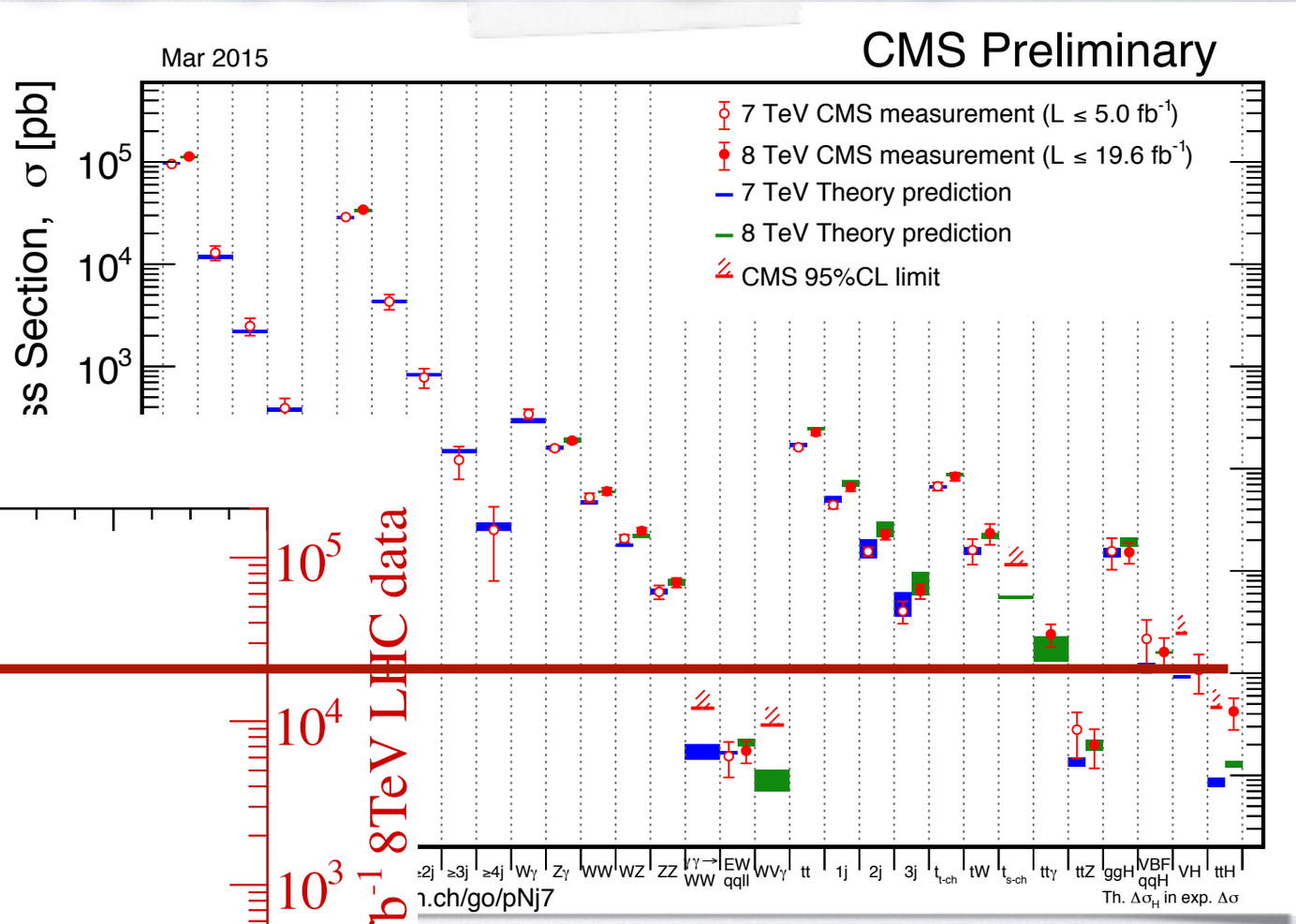
Still work in progress

UNDERSTAND SM FIRST

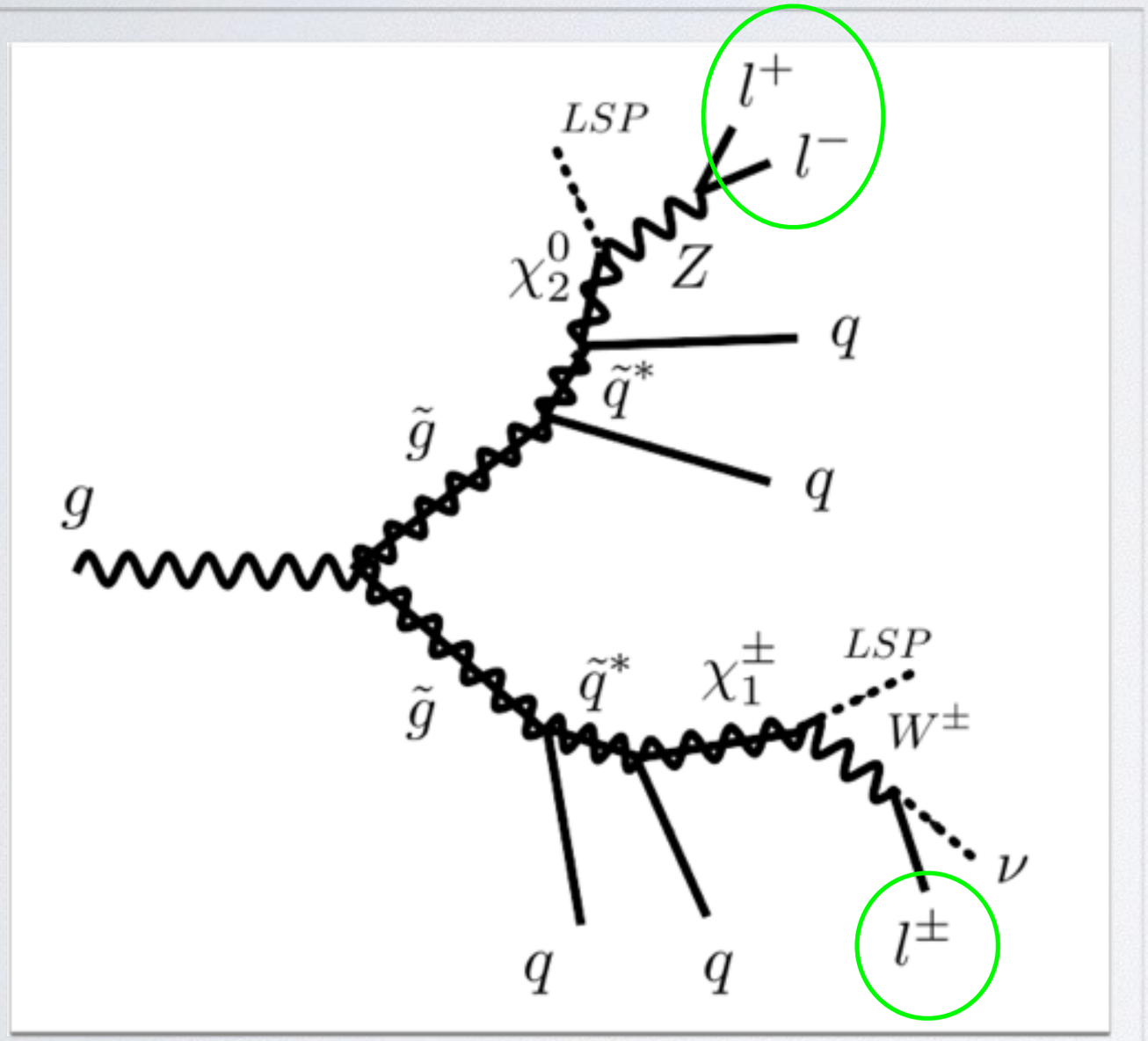


SUSY CROSS-SECTIONS





WHAT TO LOOK FOR?



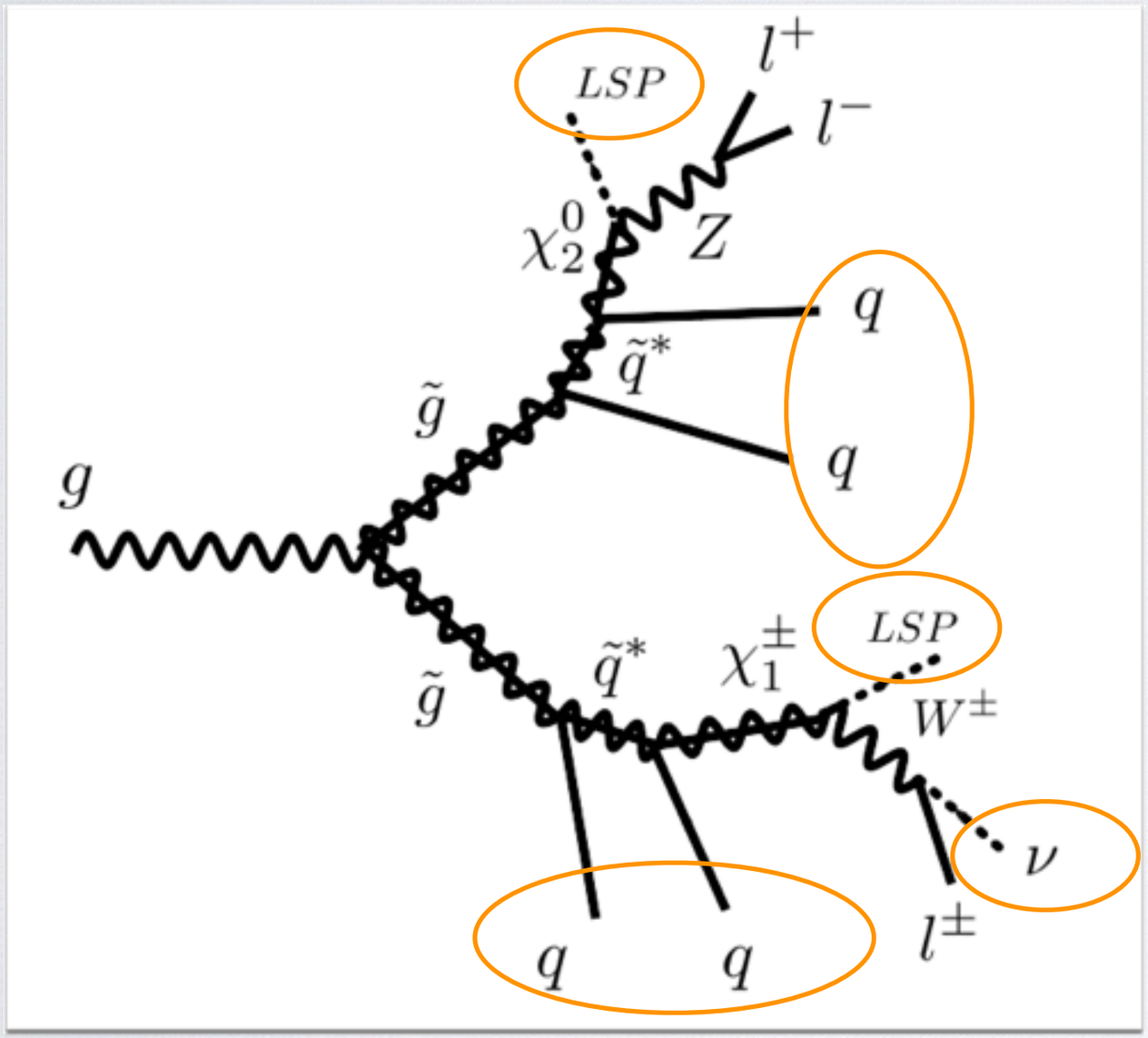
Electrons/Photons

- reconstructed with tracking and calorimetry
- high pt and isolated
- Vertex and charge

Muons

- reconstructed with tracking and muon spectrometer
- high pt - resolution
- isolation - muons in jets

WHAT TO LOOK FOR?



Jets

- cluster calorimetry energy with different algorithms
- combine tracker and calorimetry information
- calibrate the energy

MET

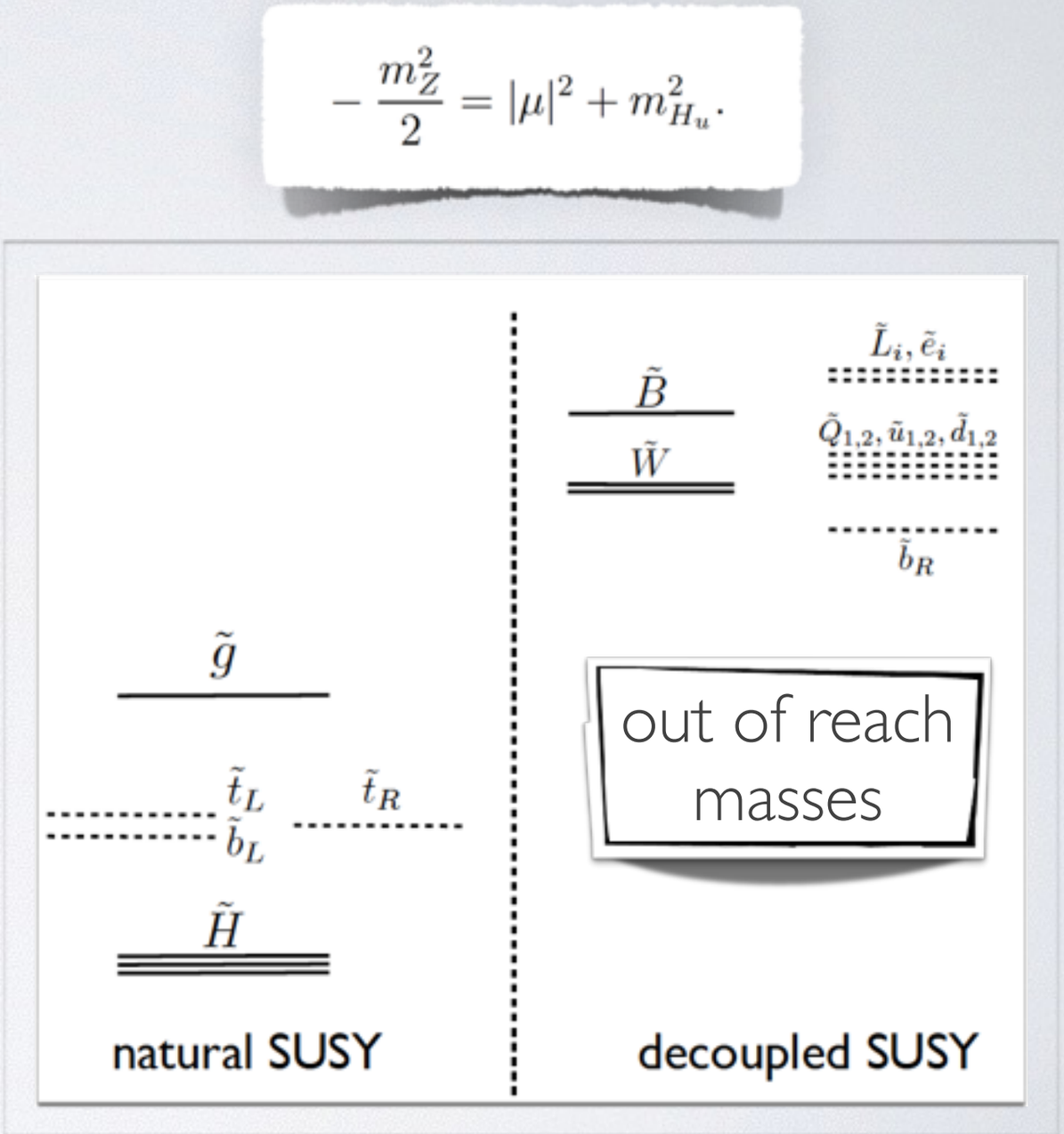
- combine all the information from different sub-detectors
- understand the response in different conditions and the effect of underlying events

NATURAL SUSY

$$-\frac{m_Z^2}{2} = |\mu|^2 + m_{H_u}^2.$$

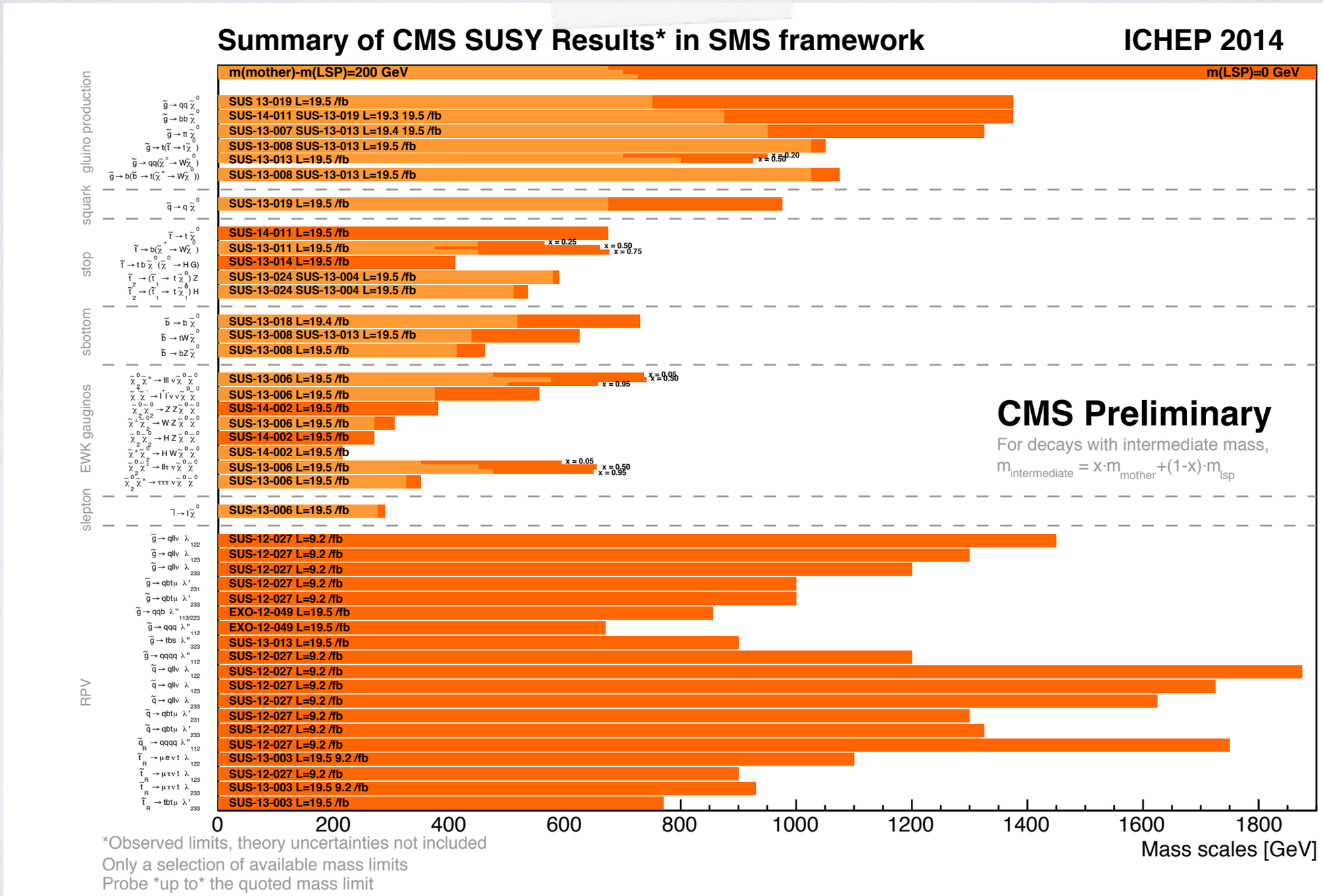
If SUSY is natural LHC is capable of discovering it

- Stop < 700 GeV
- Gluino < 1500 GeV
- Higgsino < 350 GeV



arxiv: 1110.6926

CMS SUSY OVERVIEW



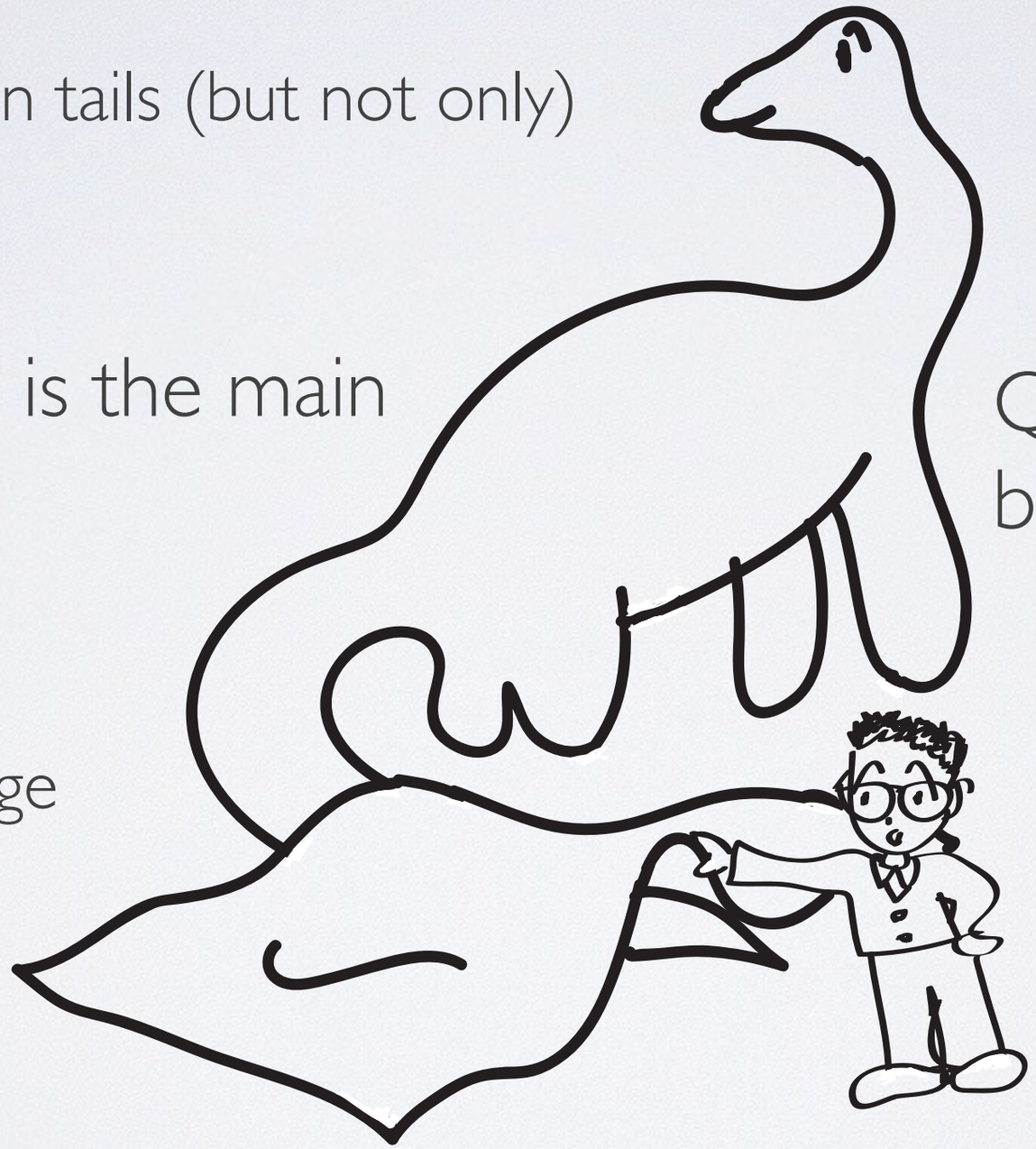
*Observed limits, theory uncertainties not included
Only a selection of available mass limits
Probe *up to* the quoted mass limit

NOT SO SIMPLE SEARCHES

Typically searches in tails (but not only)

Top production is the main background

W jets another large source

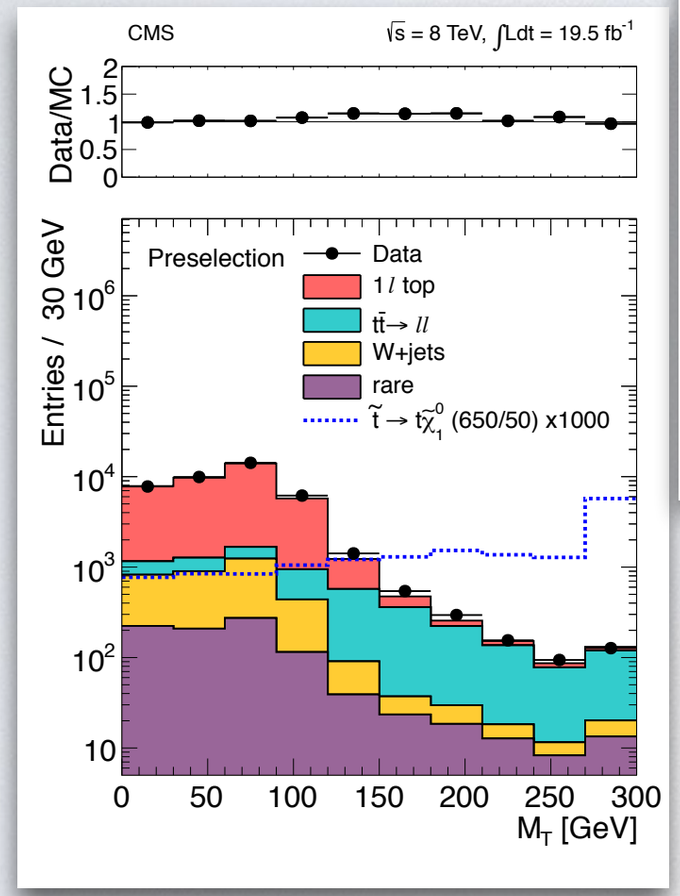


QCD easier to kill but everywhere

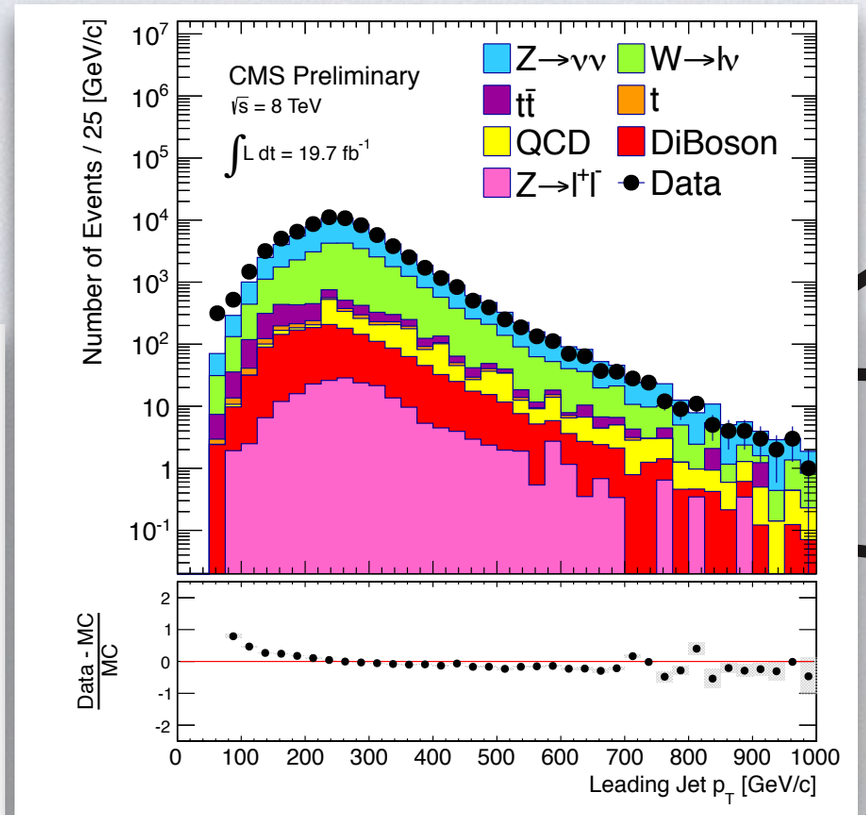
Z to invisible also tricky

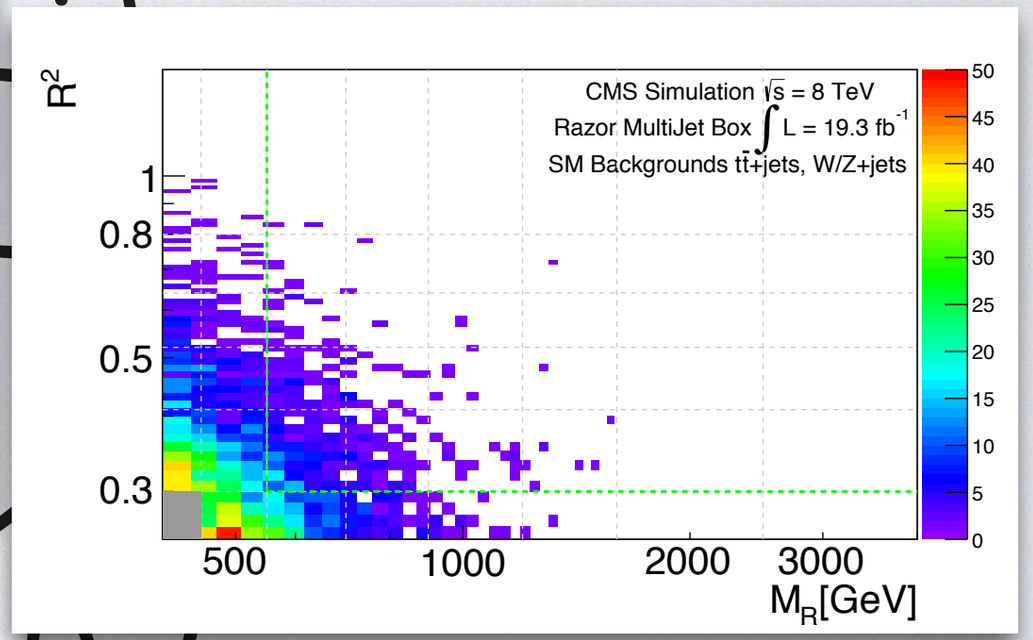
BIG NEWS - NO EXCESS

CMS-SUS-13-009



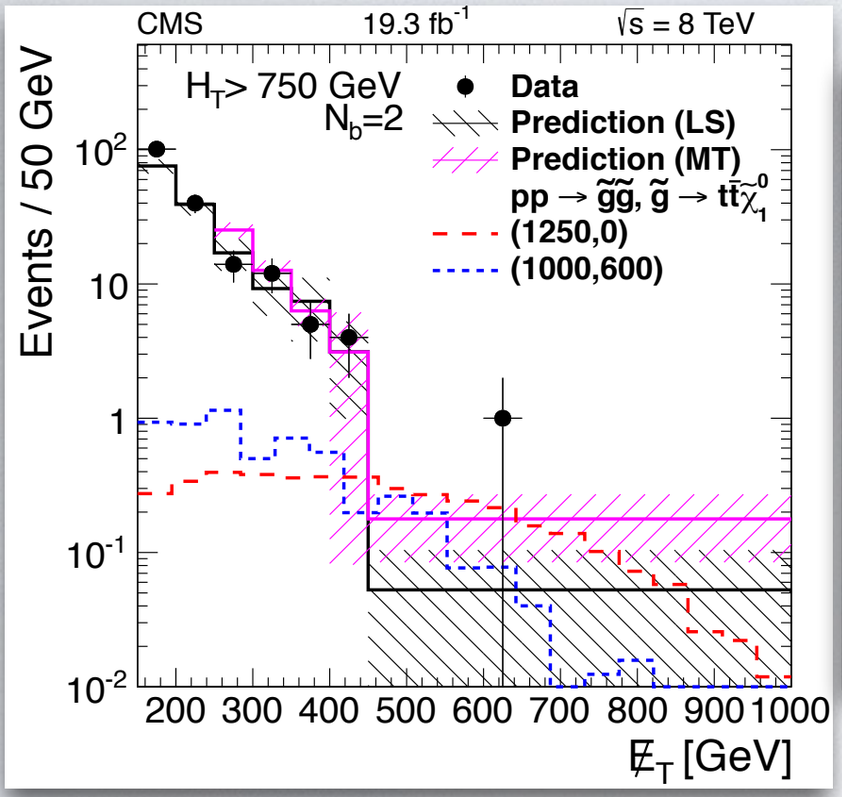
CMS-SUS-13-011





CMS-SUS-13-004

BIG NEWS - NO EXCESS



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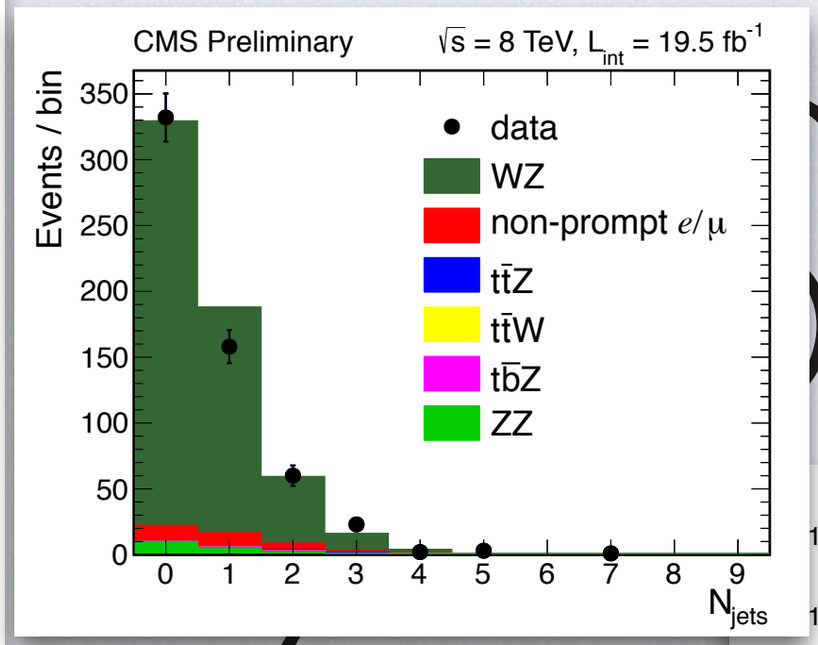

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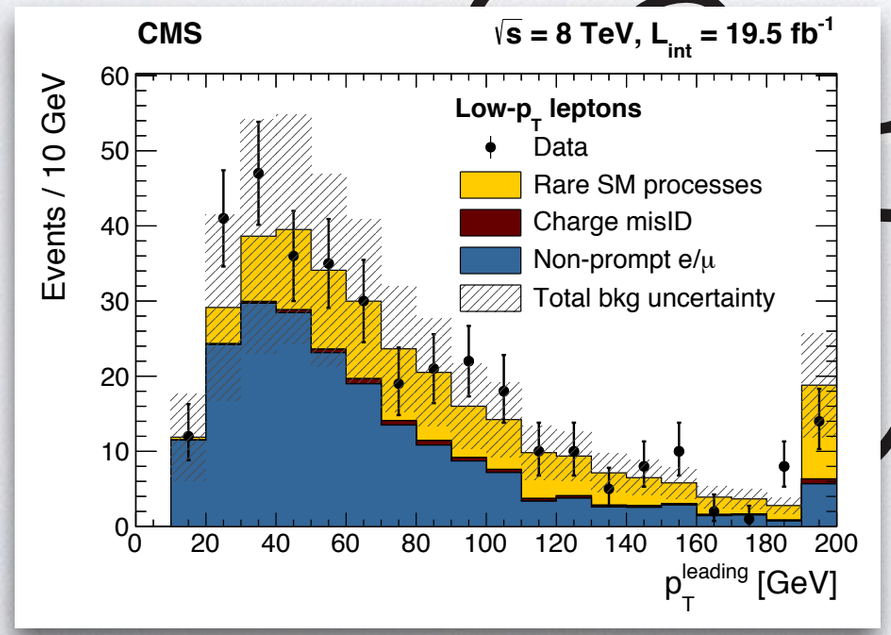
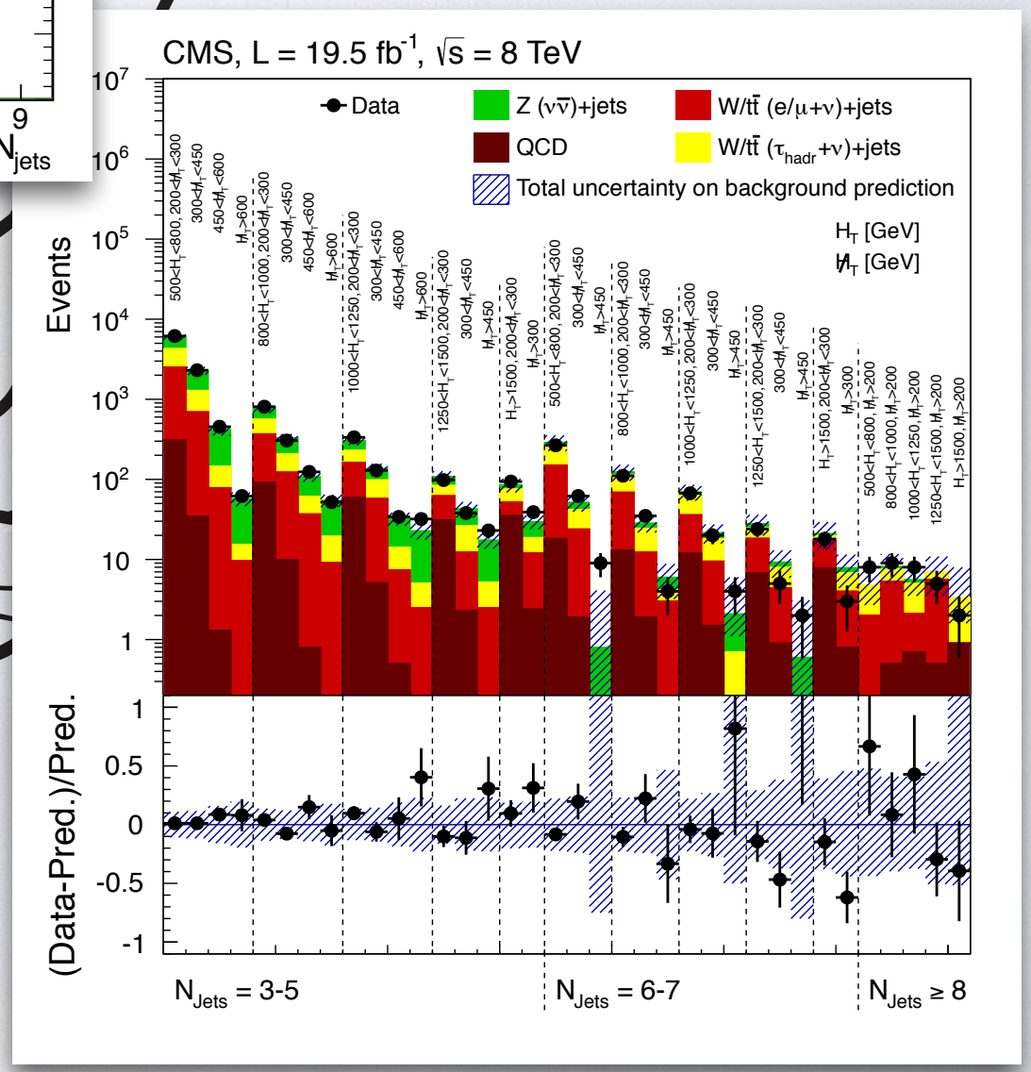
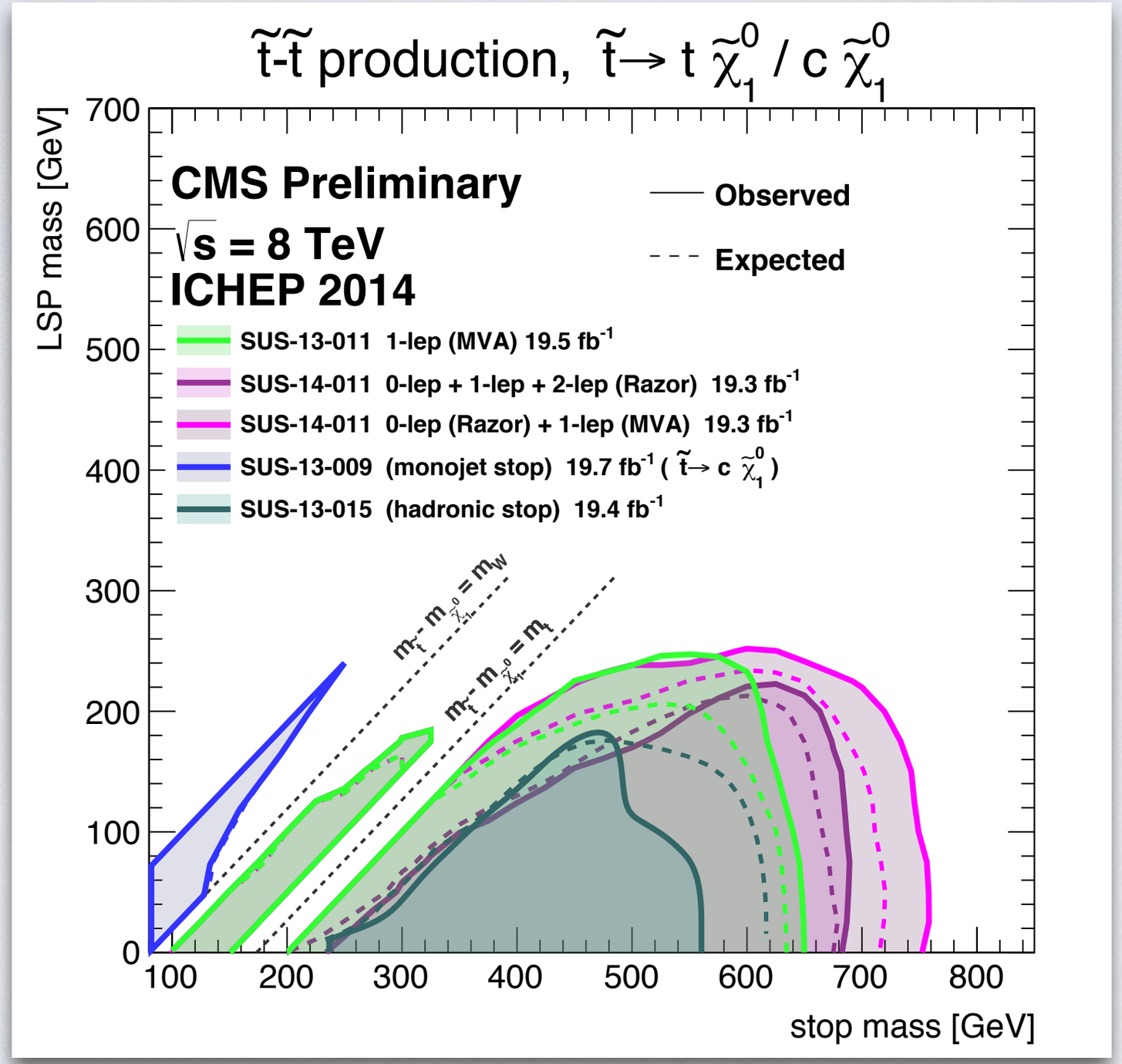


CMS-SUS-13-013

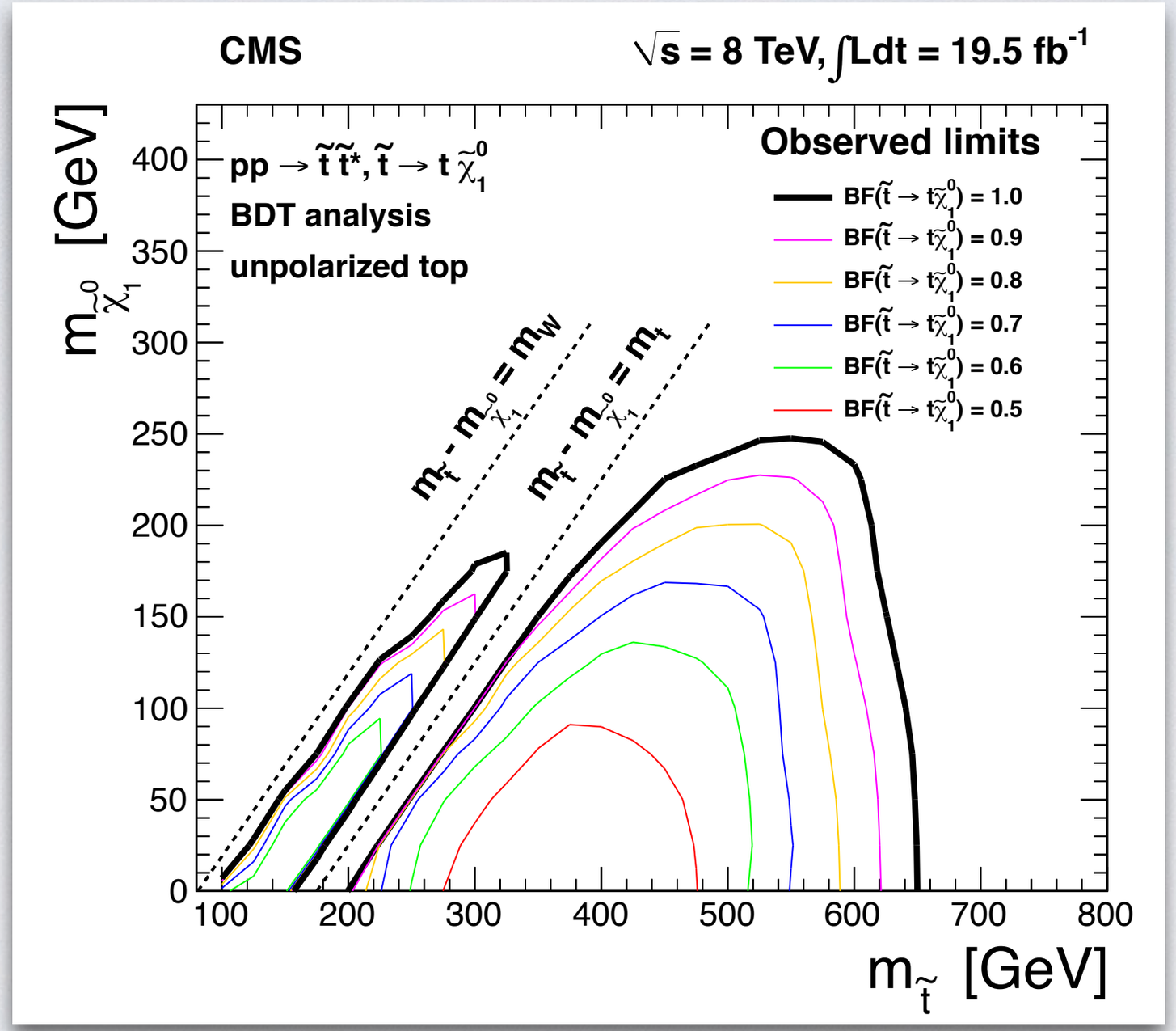


CMS-SUS-13-012

INTERPRETING THE RESULTS



DEPENDENCY ON BF



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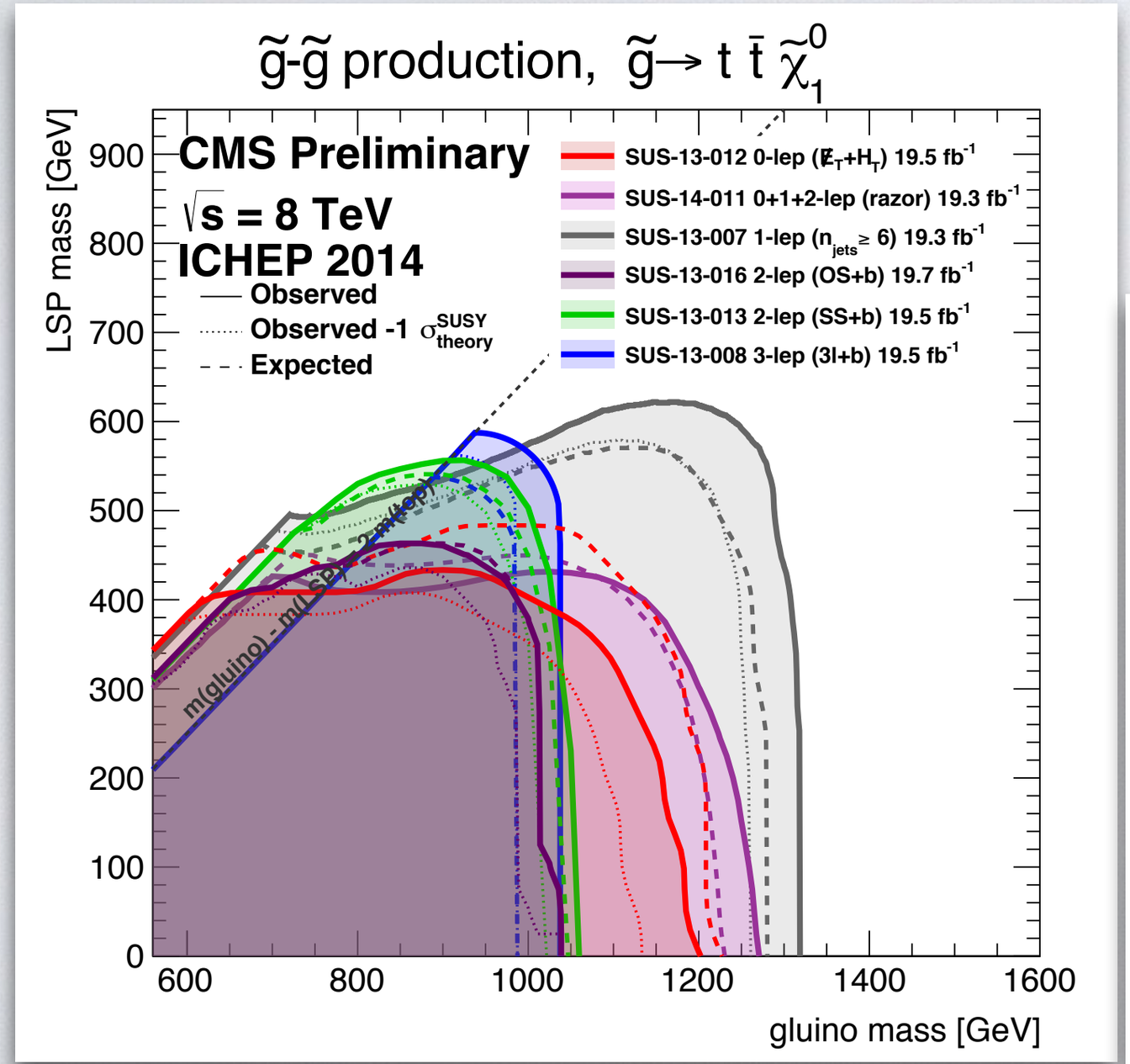
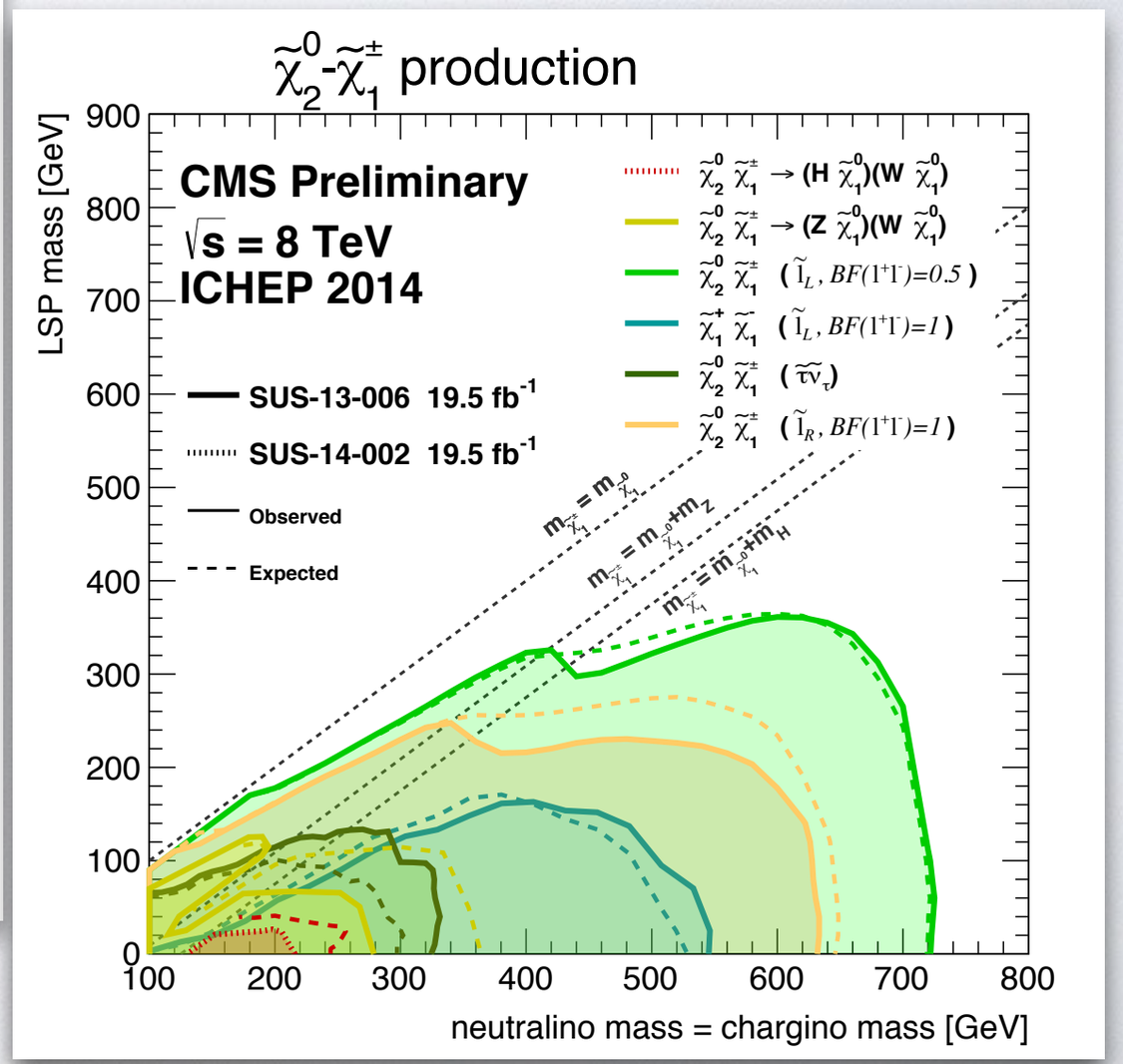
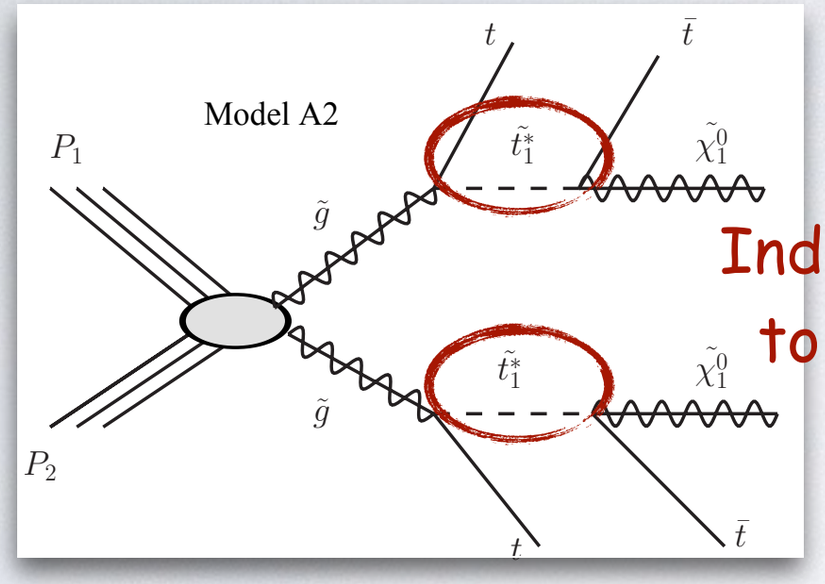
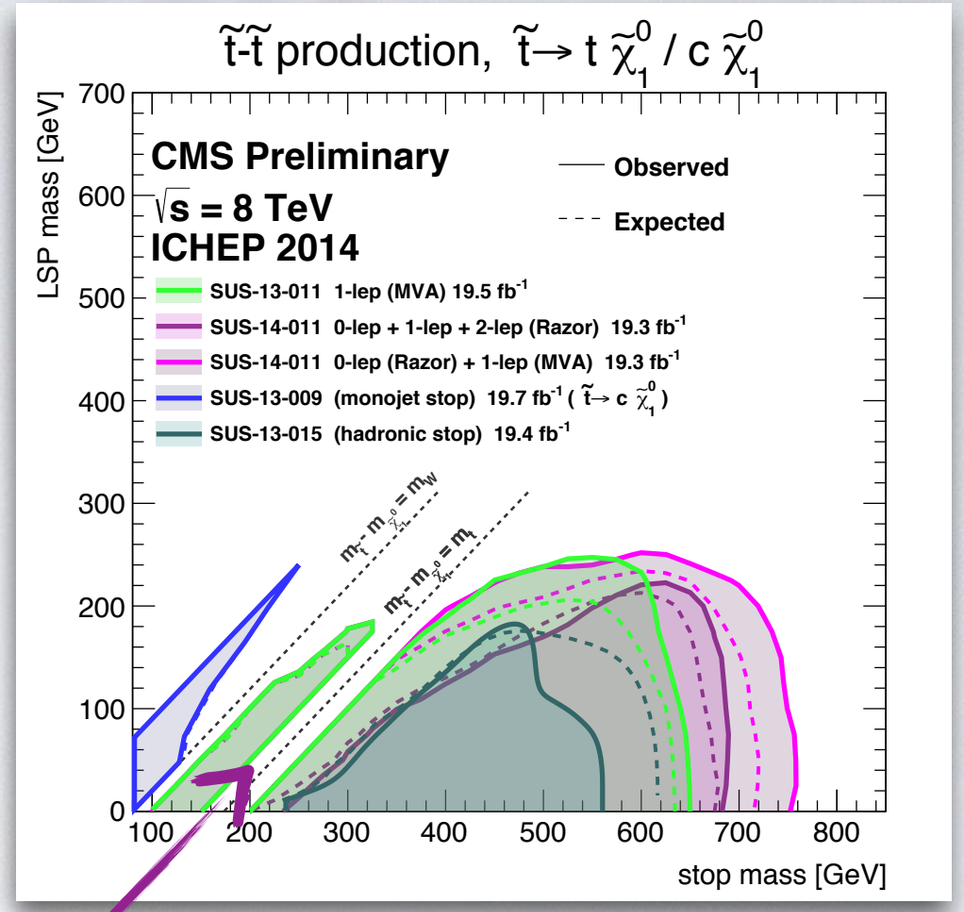


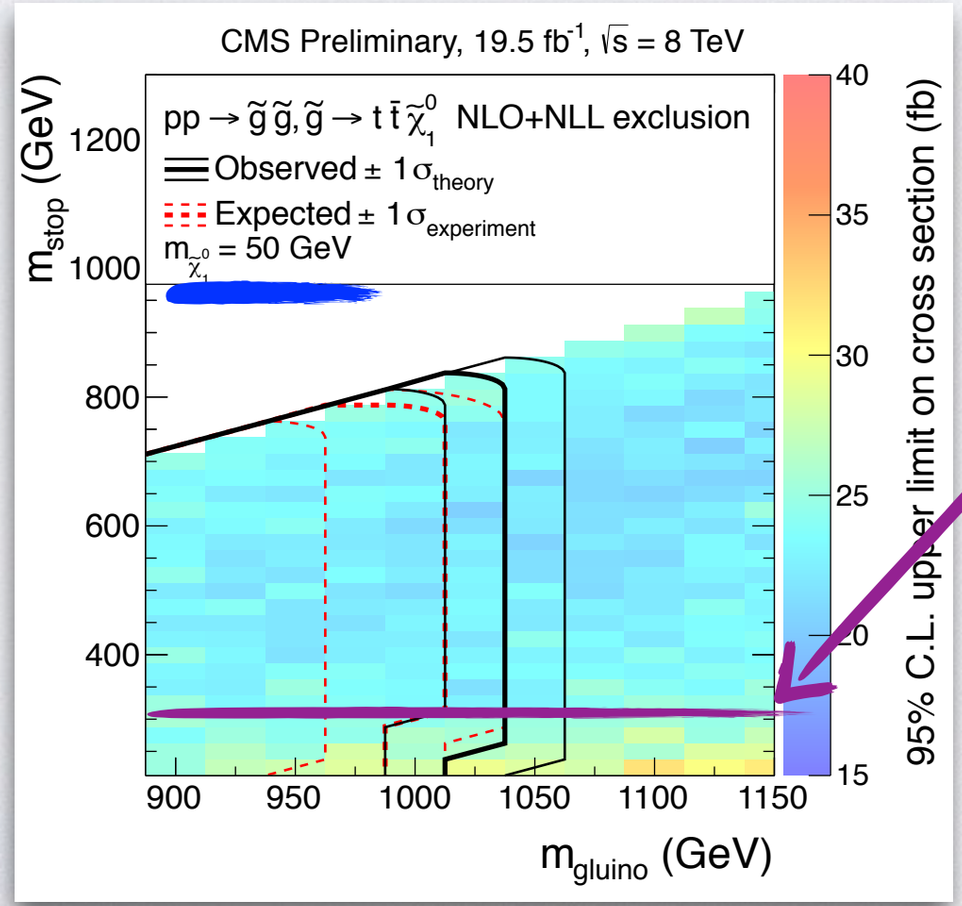


INDIRECT ACCESS



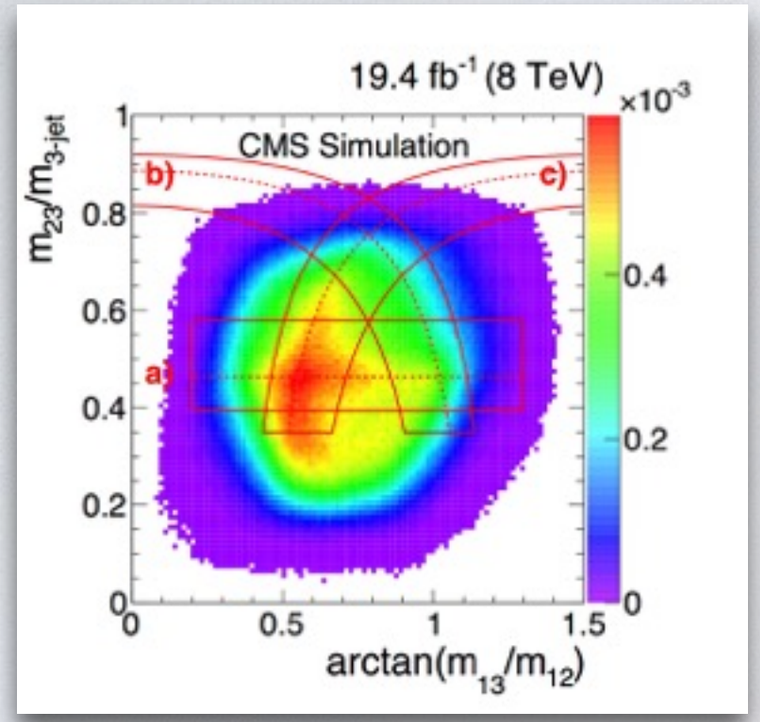
Indirect access to Stop mass



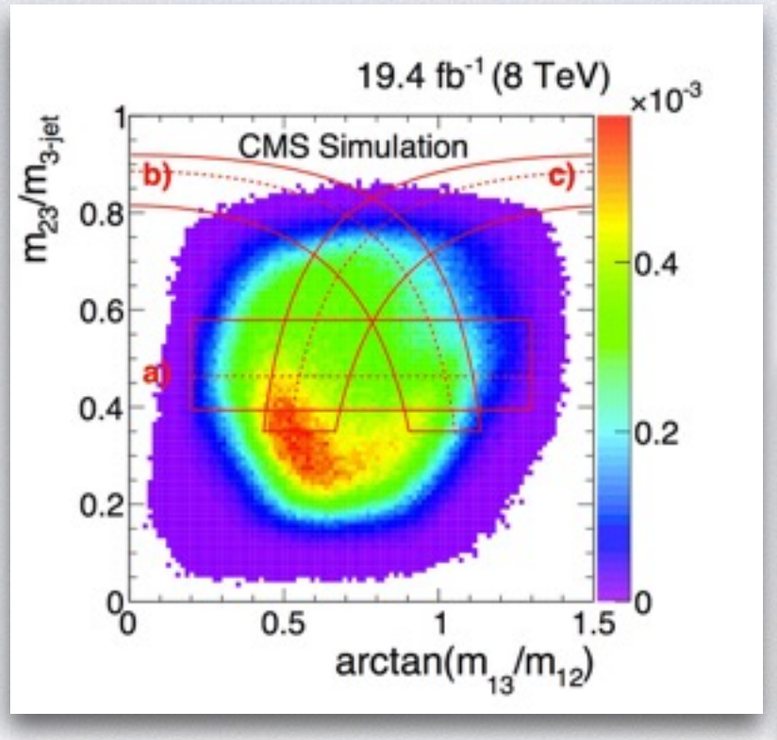


We can fill the gaps using other doors as well

NEW DI-JETS

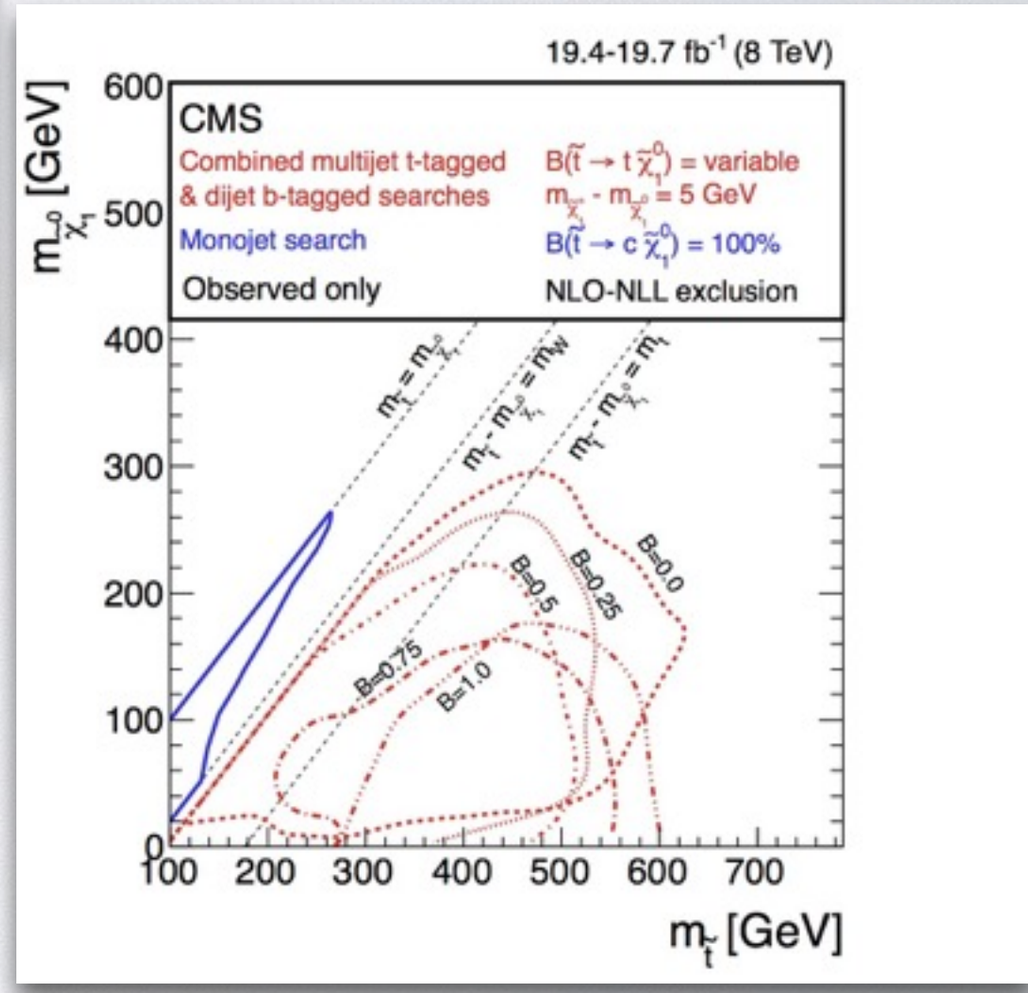


ttbar



QCD

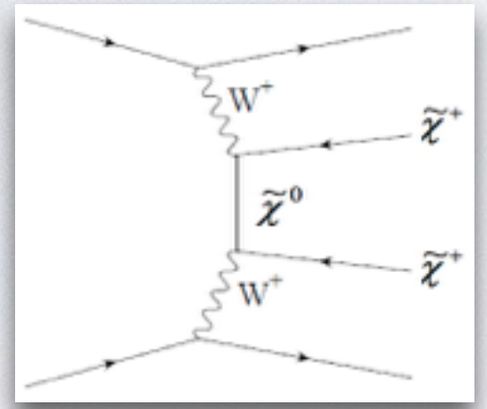
CMS-SUS-14-001



New effort to cover regions with difficult reach where Stop and Top have the same mass.

COMPRESSED SUSY?

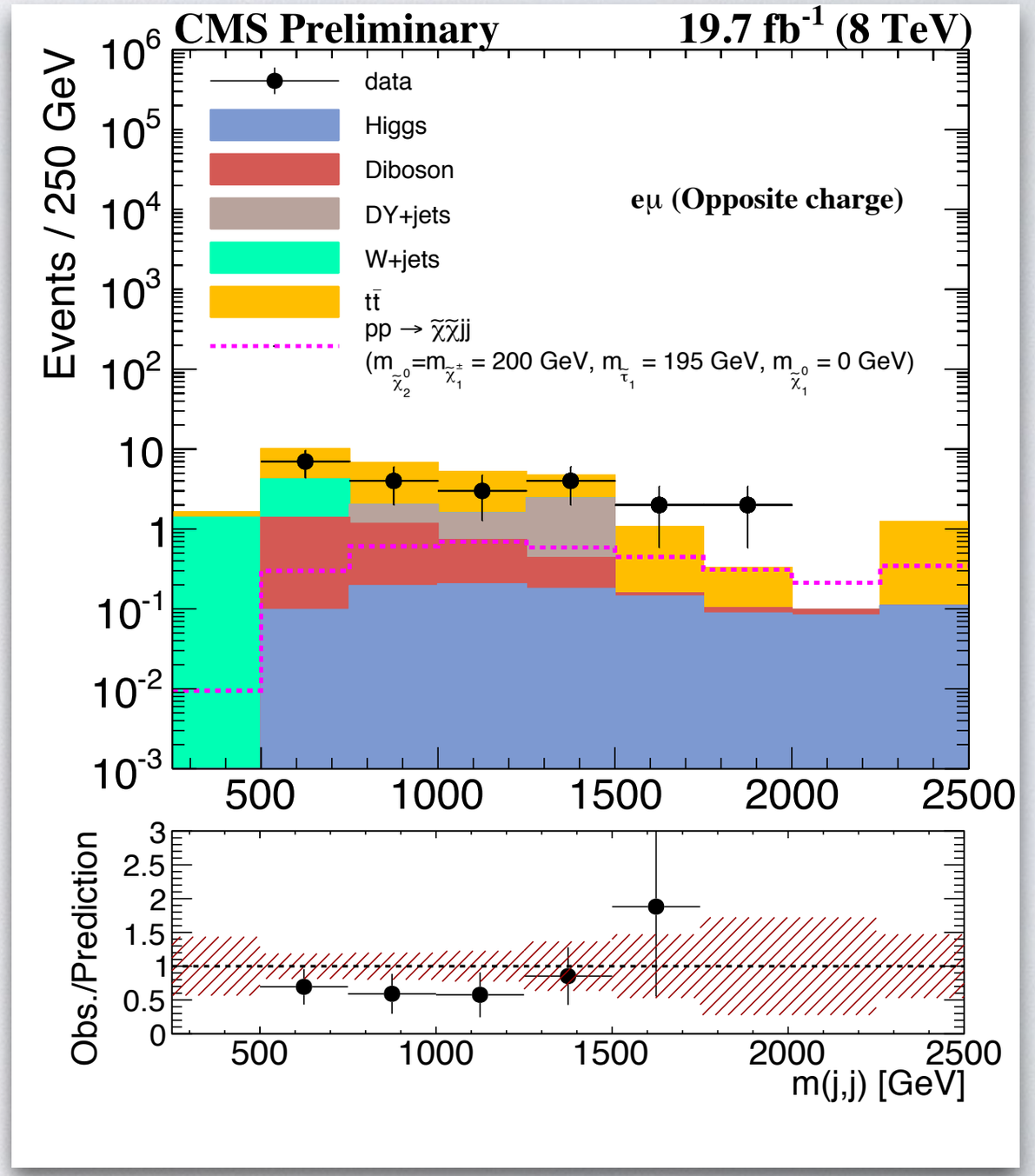
- Compressed spectra are dominating the late 8 TeV analyses



- New techniques exploring these scenarios as Vector Boson Fusion

- Boosting and Initial State Radiation is also used to explore compressed SUSY phase spaces

CMS-SUS-14-005



BEFORE LHC RUN I

AFTER LHC RUN I

SO WHAT IS NEXT?

- LHC so far has found no evidence of SUSY particles
- Run1 data are still being exploited to turn every stone
- Nonetheless SUSY is still far from being dead
- Surprises can still happen in RUN2


SUSY
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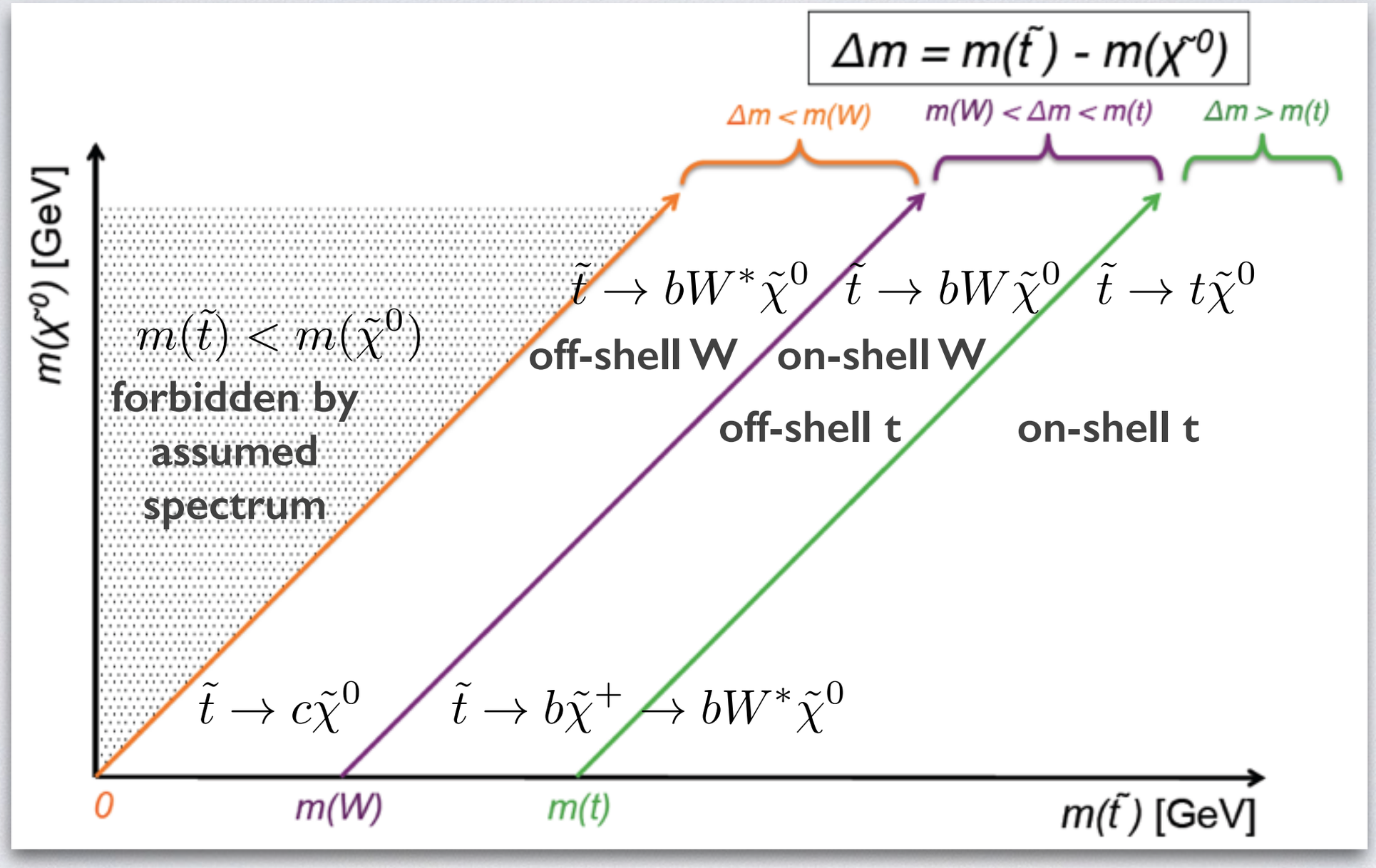
Prossimamente
@CERN

BACKUP

DIRECT STOP PRODUCTION



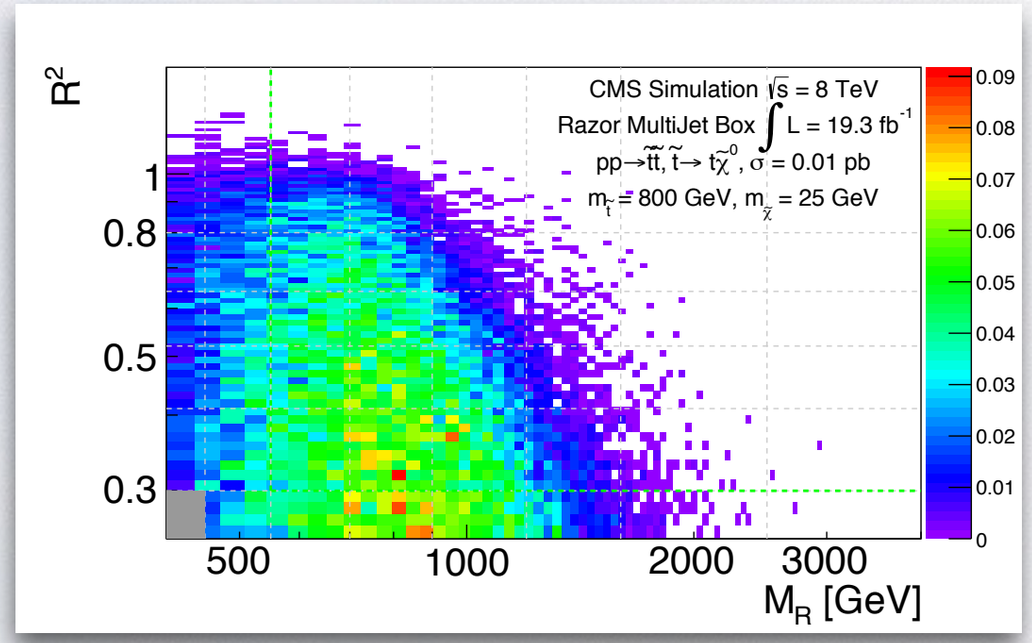
RAZOR SEARCHES

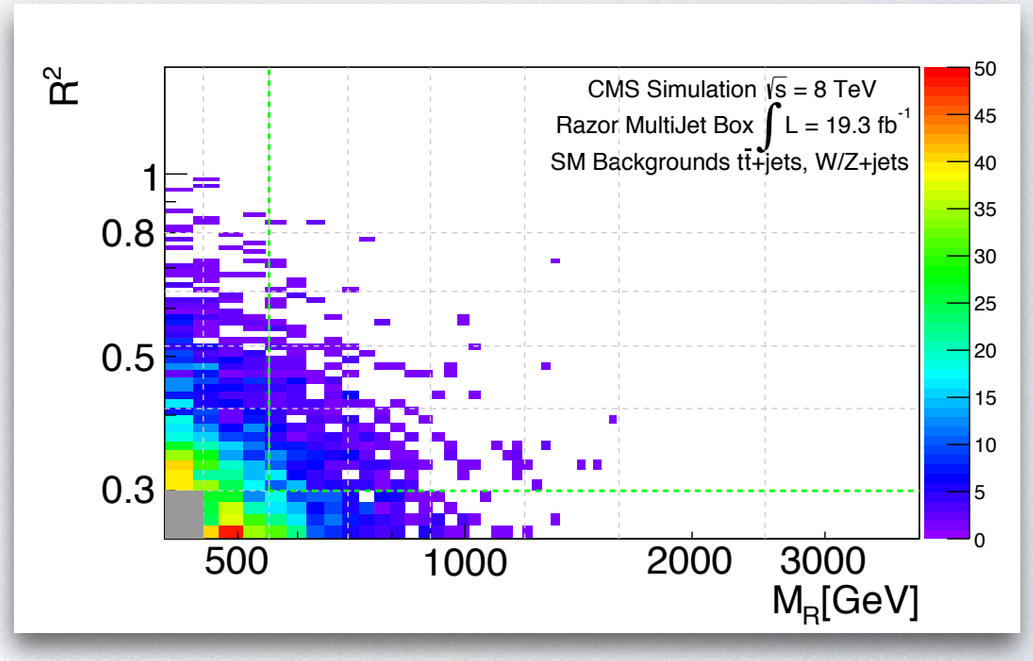
- Cluster all the particles into two "megajets"
- Starting form at lest two jets above 80 GeV (all jets above 40 GeV used to compute the razor variables)
- 1 b-tagged jet at least

$$M_R \equiv \sqrt{(p_{j1} + p_{j2})^2 - (p_z^{j1} + p_z^{j2})^2}$$

$$M_T^R \equiv \sqrt{\not{E}_T(p_T^{j1} + p_T^{j2}) - \vec{\not{E}}_T \cdot (\vec{p}_T^{j1} + \vec{p}_T^{j2})}$$

$$R \equiv \frac{M_T^R}{M_R}$$





CMS-SUS-13-004