Searches for new physics using taus at CMS

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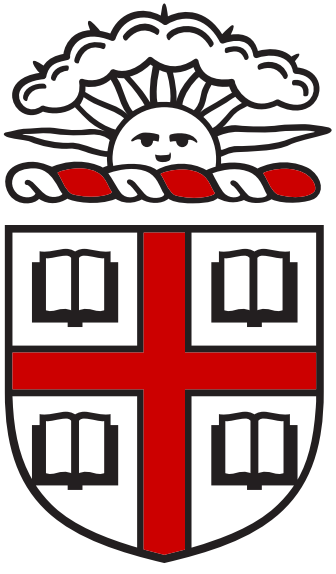
on behalf of the CMS Collaboration



Rencontres de Blois 2016

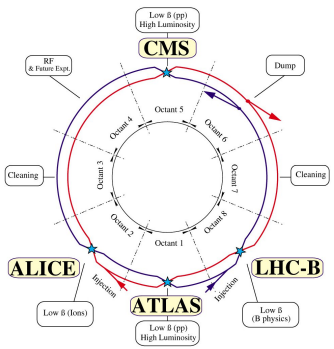
Scope of talk

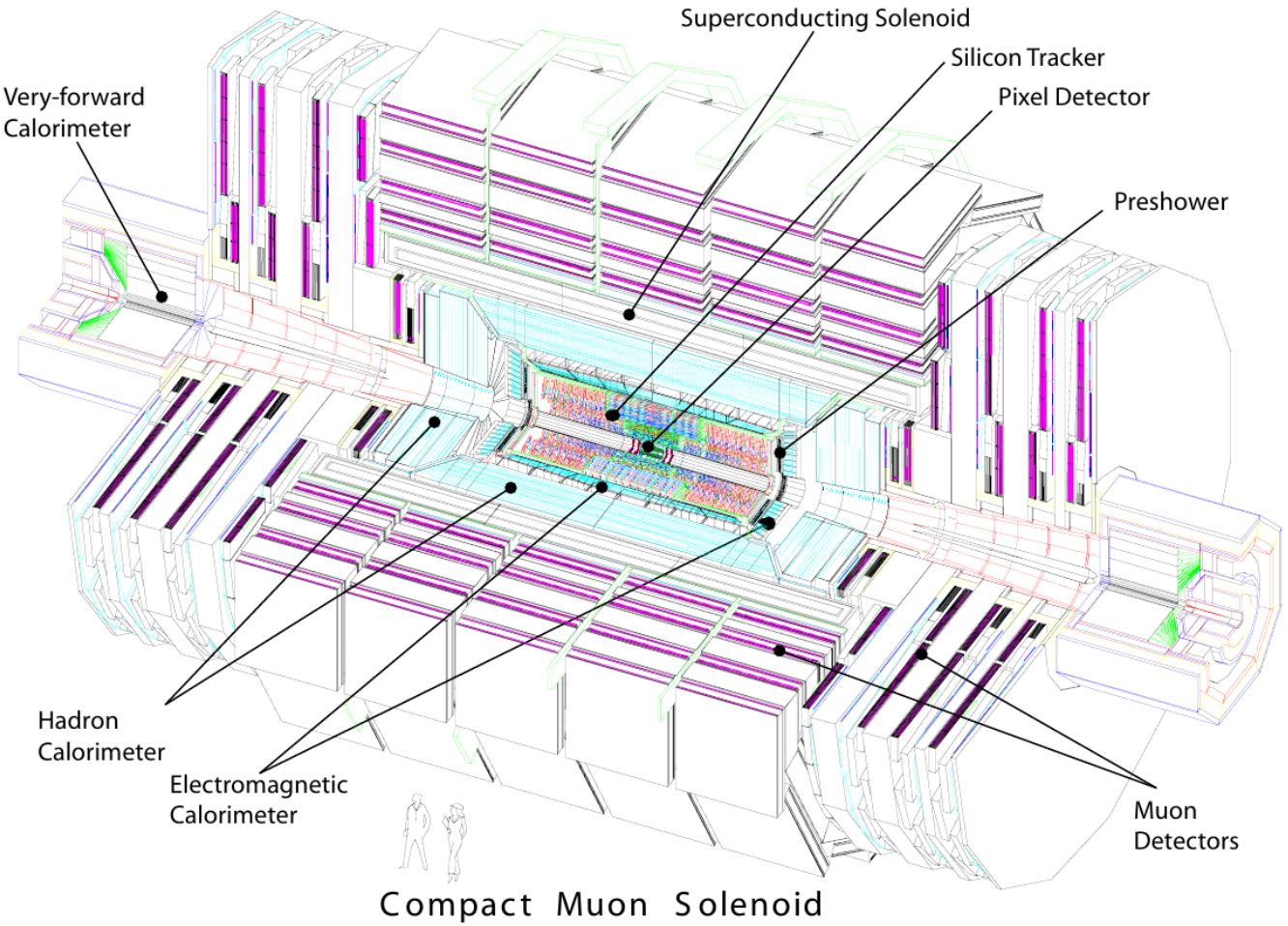
- many CMS searches use taus
- 15 mins $\Longrightarrow$ will discuss only a selection of them
- focus on signatures targeting SUSY or exotics,
  but won't cover Higgs or (N)MSSM

- full documentation available at

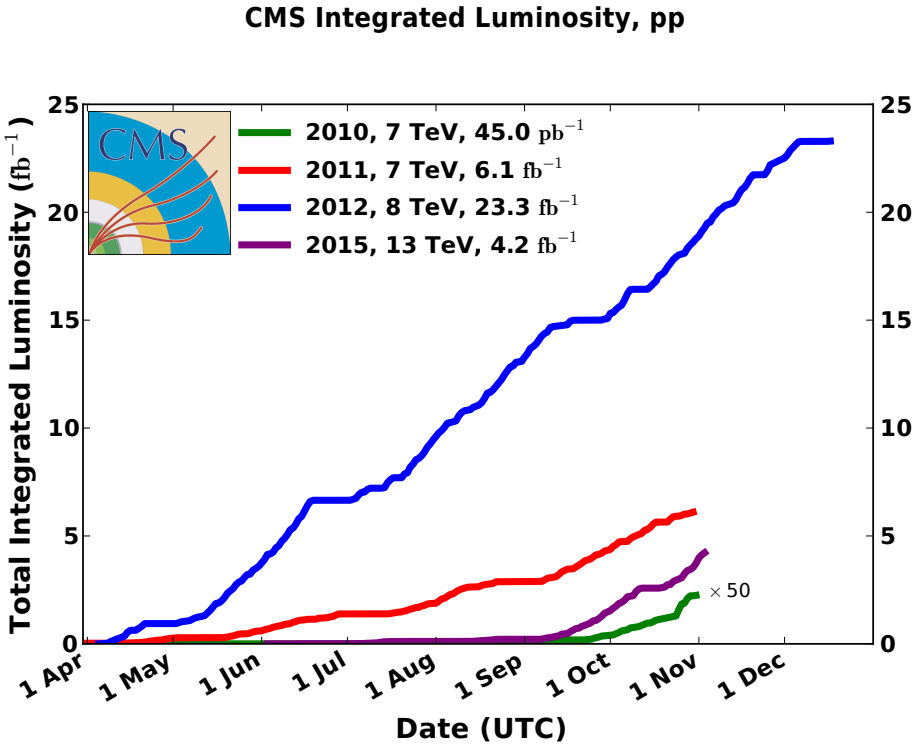
http://cms-results.web.cern.ch/cms-results/public-results/publications/

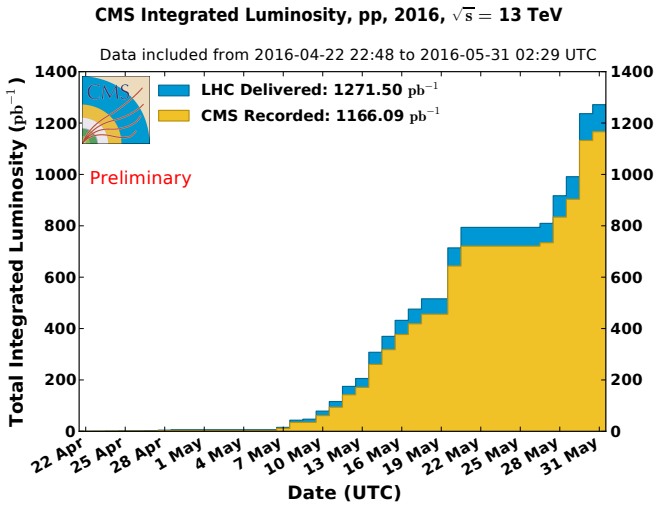
Compact Muon Solenoid (CMS) at LHC





Luminosity of datasets



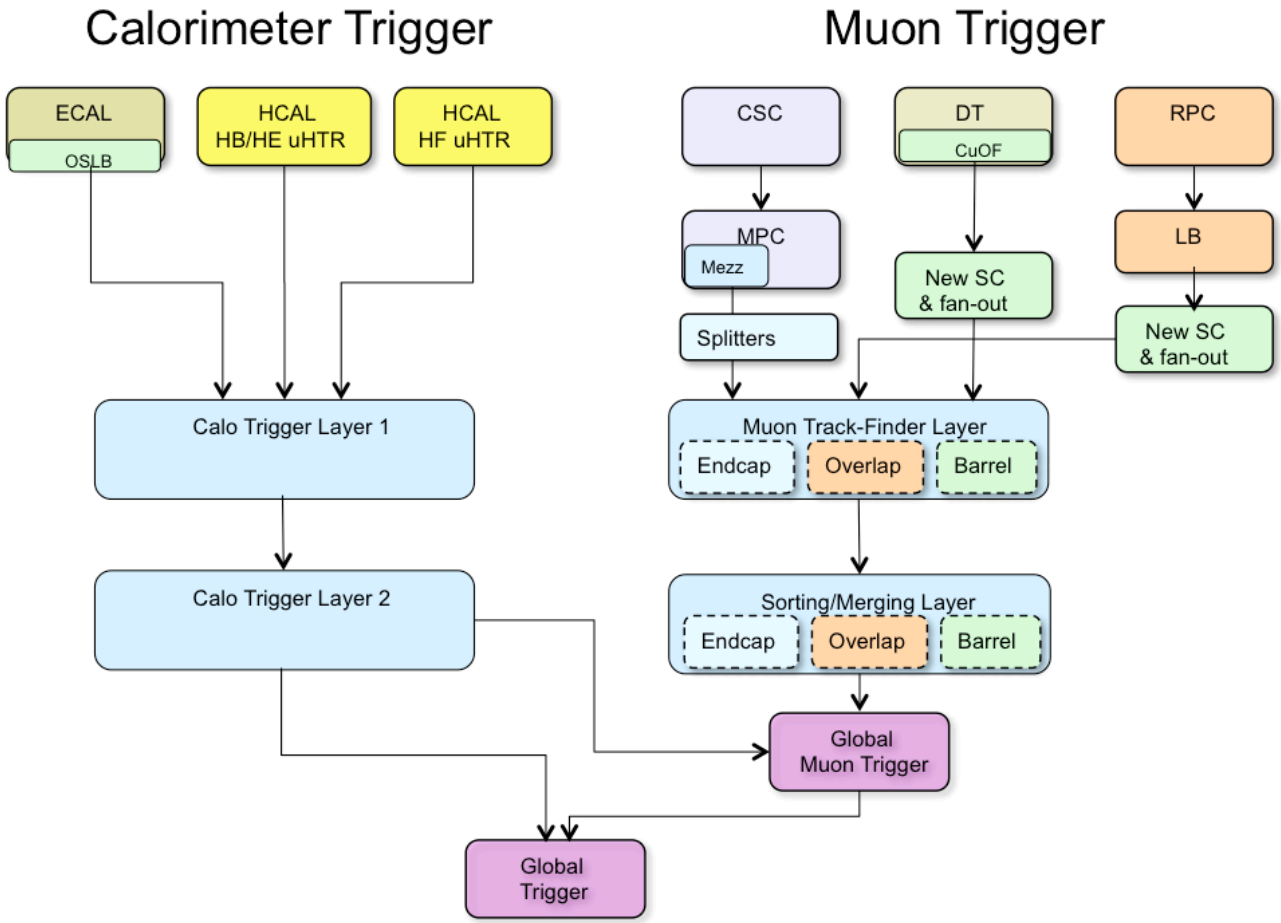


tau lepton (τ)

Decay mode	Meson resonance	$\mathcal{B}$ [%]
$\tau^- \to e^- \overline{\nu}_e \nu_\tau$		17.8
$\tau^- \to \mu^- \overline{\nu}_\mu \nu_\tau$		17.4
$\tau^- \to h^- \nu_\tau$		11.5
$\tau^- \to h^- \pi^0 \nu_\tau$	$\rho(770)$	26.0
$\tau^- \to h^- \pi^0 \pi^0 \nu_\tau$	$a_1(1260)$	9.5
$\tau^- \to h^- h^+ h^- \nu_\tau$	$a_1(1260)$	9.8
$\tau^- \to h^- h^+ h^- \pi^0 \nu_\tau$		4.8
Other modes with hadrons		3.2
All modes containing hadrons		64.8

- m = 1.777 GeV
- $c\langle t \rangle = 87\ \mu$m
- n.p. motivation: relevant $BR(H \to \tau\tau)$, 3rd gen., $\tilde{\tau}$

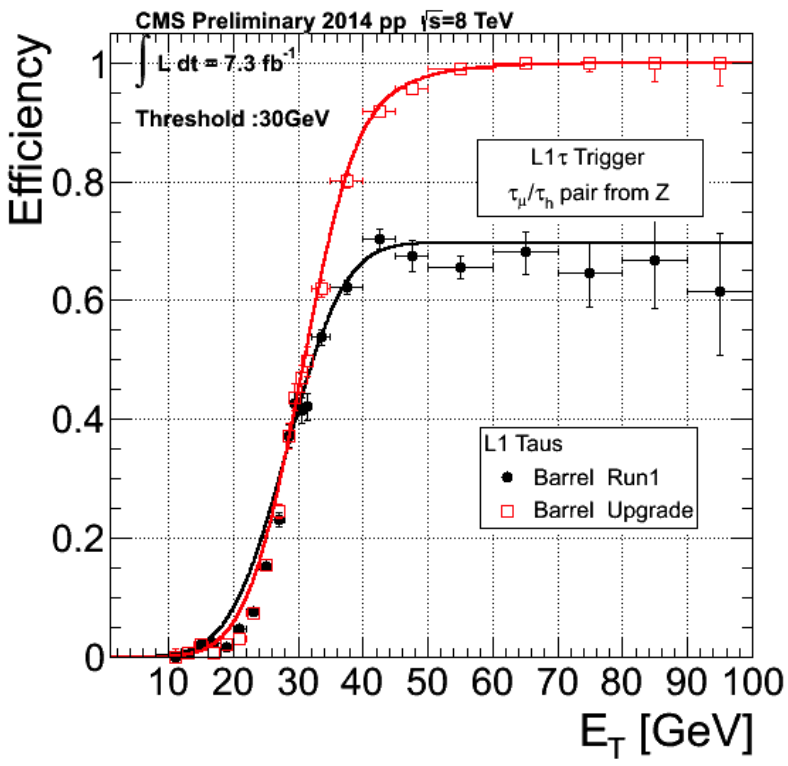
Level-one trigger: major upgrade for 2016

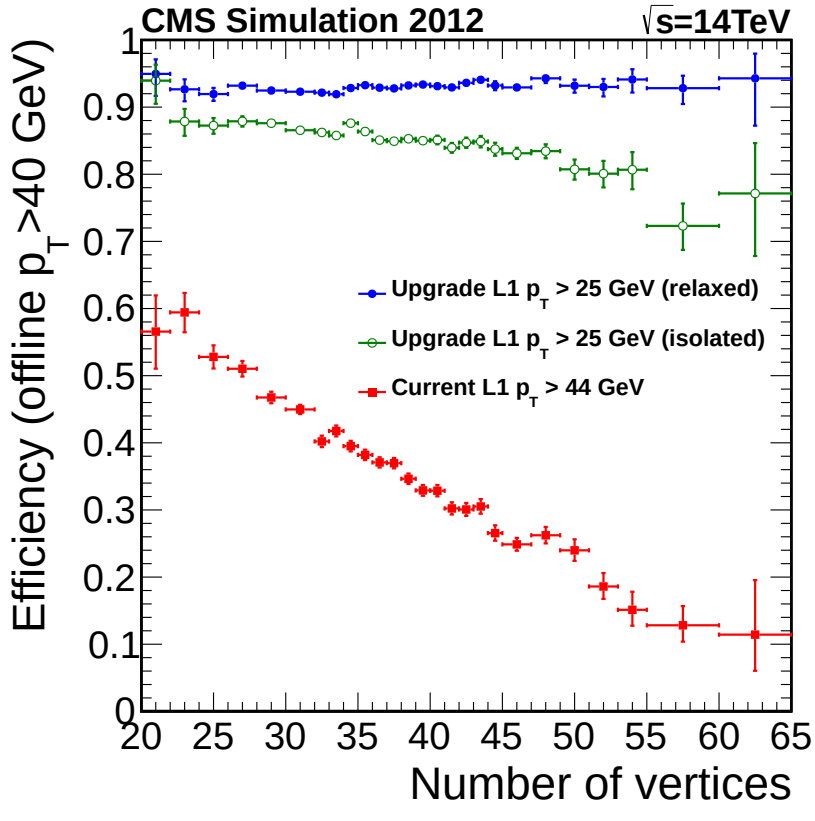


- esp. spatial granularity, iso. calc., PU-robustness

CMS-TDR-12

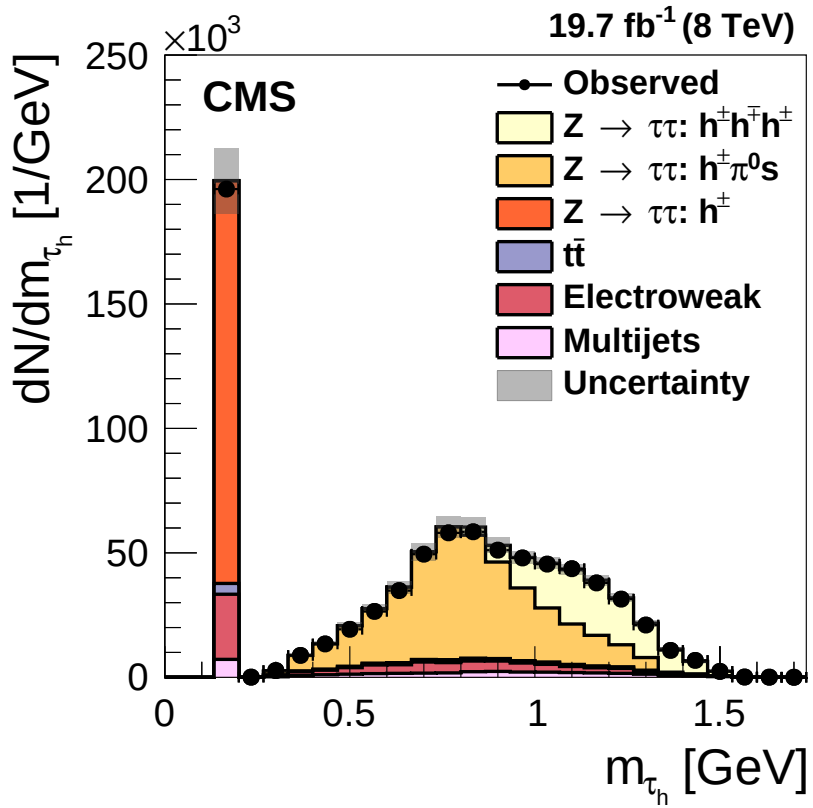
Expected performance of trigger upgrade





CMS-TDR-12

τ_h reconstruction

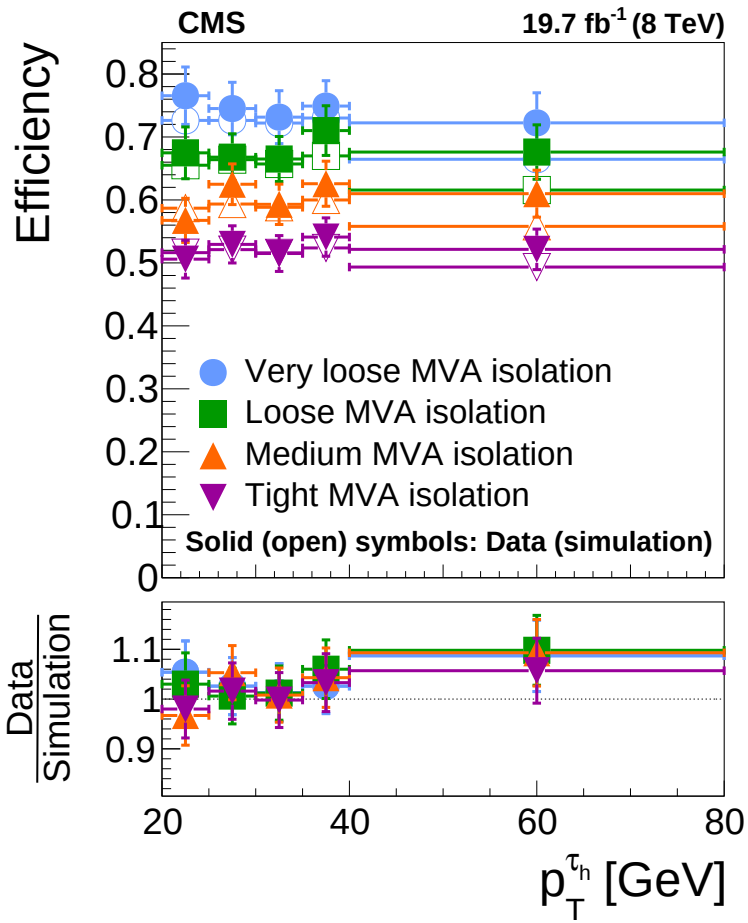


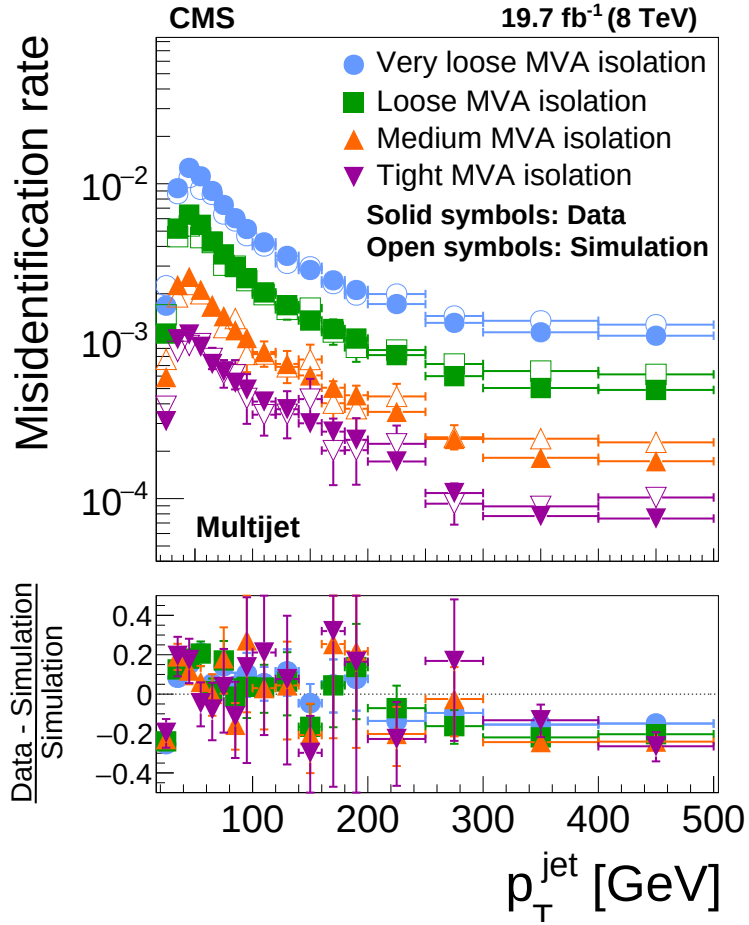
Combine particle-flow candidates:

- charged hadron(s) +
- π^0('s) in strips

TAU-14-001

τ_h identification





- charge mis-ID $\sim 1\%$

TAU-14-001

Standard model backgrounds: typical estimation methods

Drell-Yan / top / rare SM

- simulate using Powheg/MadGraph + Pythia + det. response
- derive scale factors and corrections
- validate/evaluate syst. in control regions

W+jets, either

sim as above, taking special care of fake τ_h's

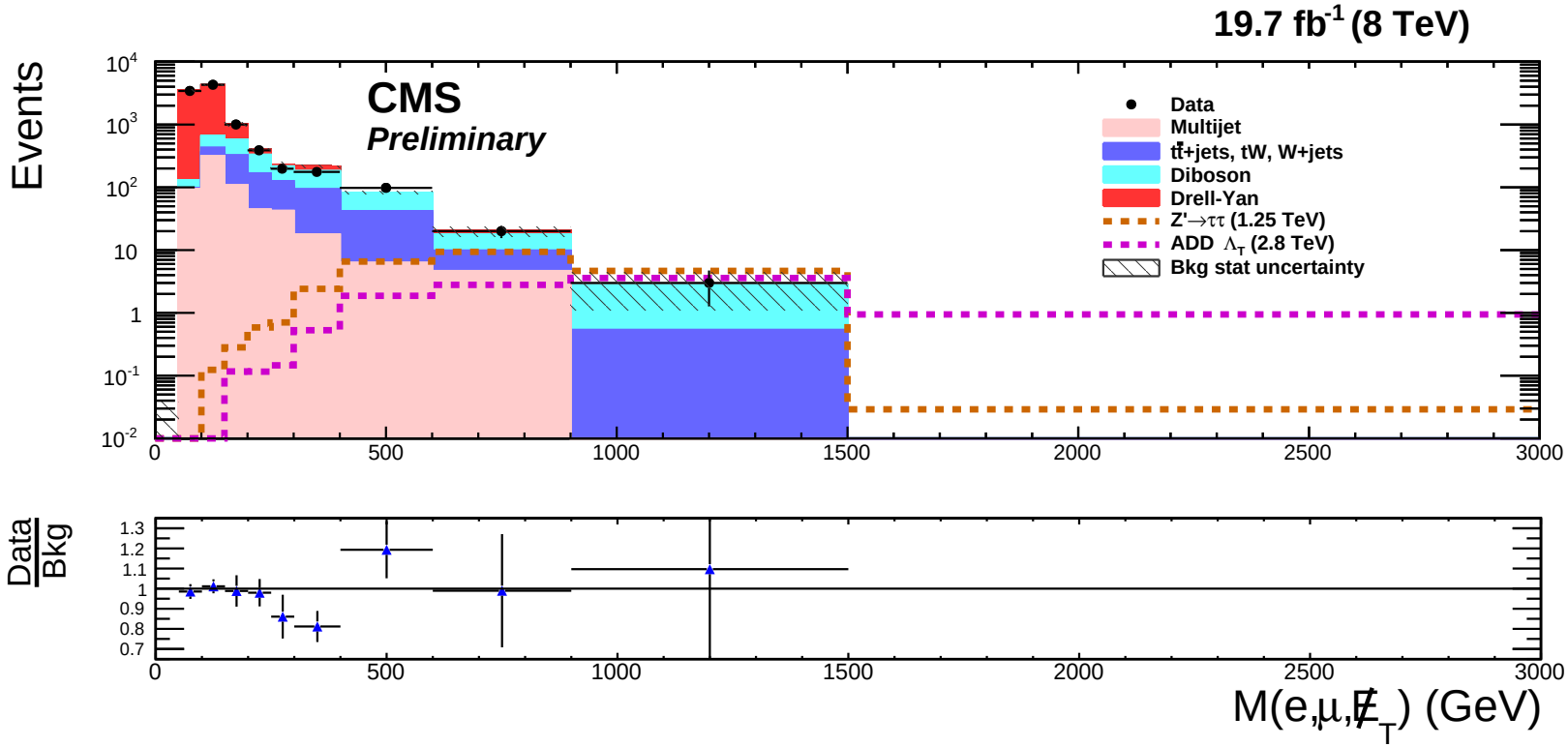
or

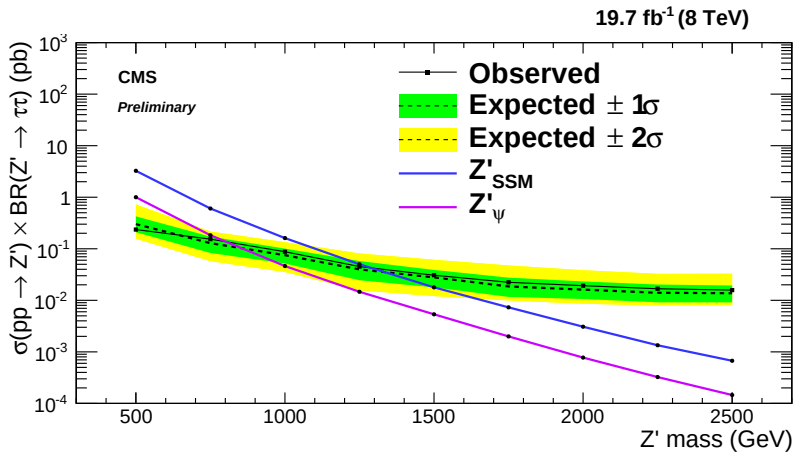
data W-enriched control sample, possibly via relaxed τ_h isolation

QCD multijet

- data control region, often using two same-sign τ_h candidates and/or relaxed τ_h isolation

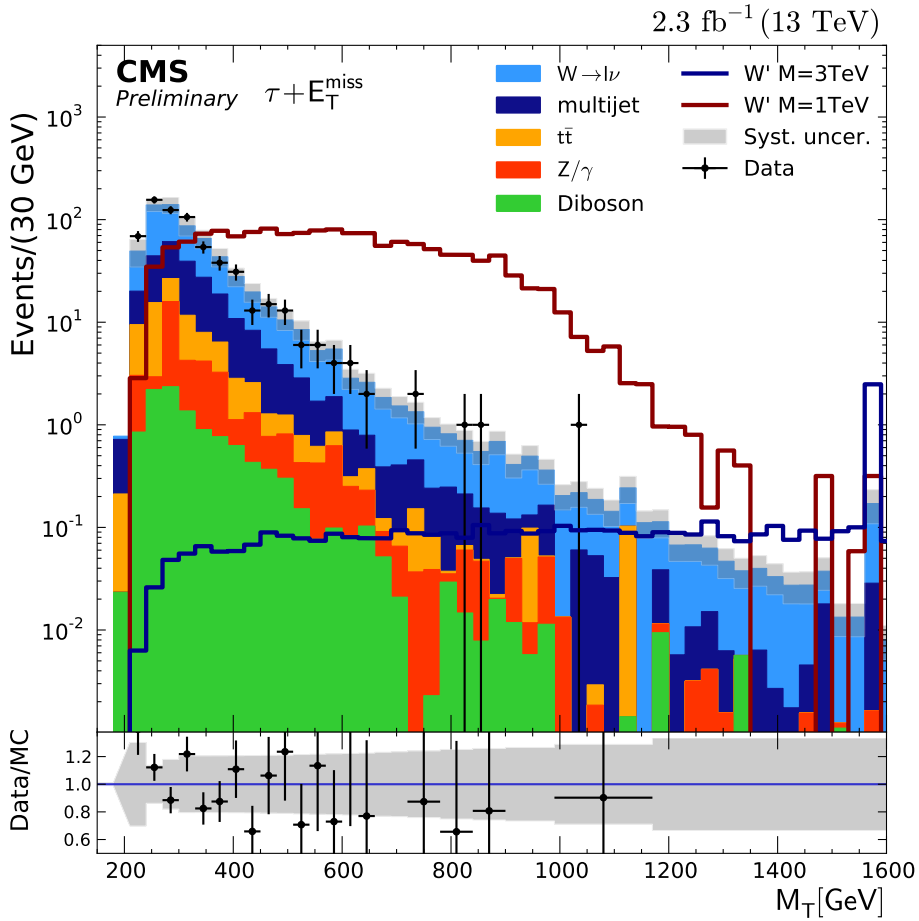
Results: $Z' \to \tau^+\tau^-$ (with $\tau_e\tau_\mu$)

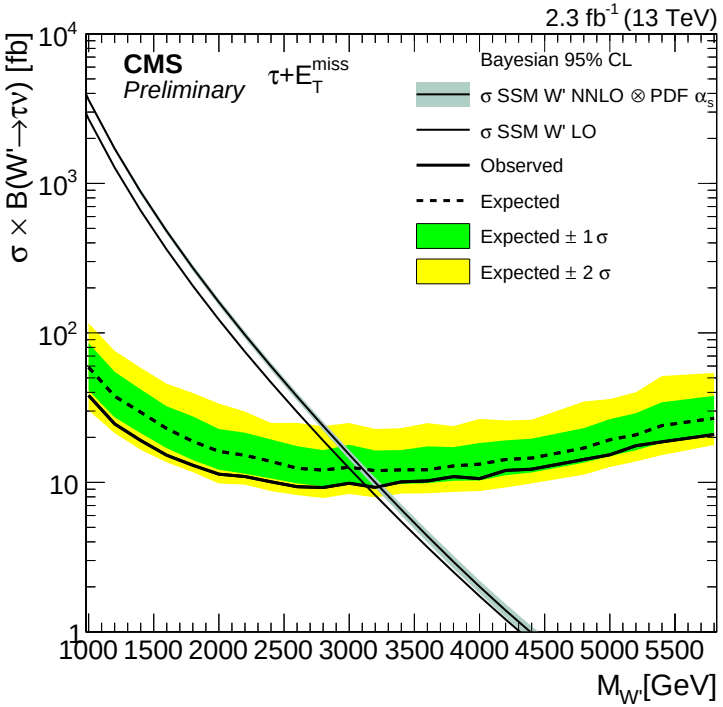




EXO-12-046

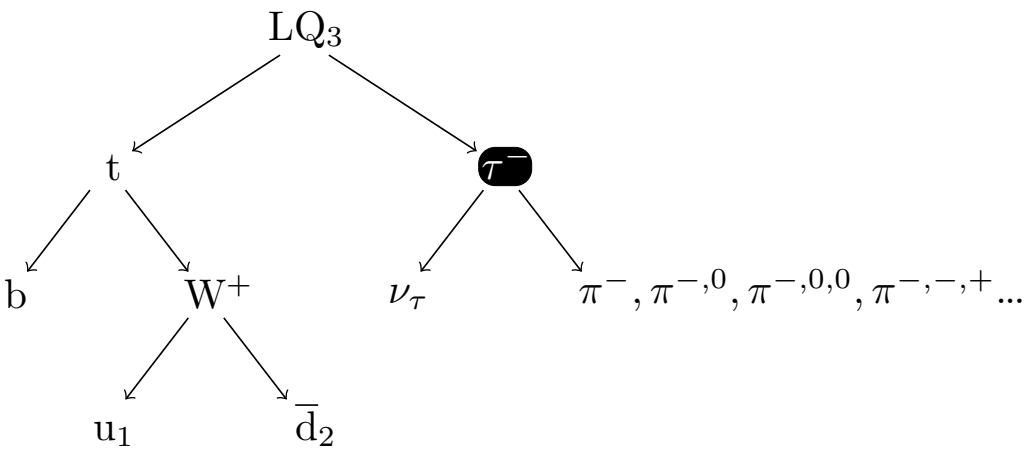
Results: $W' \to \tau_h \nu$

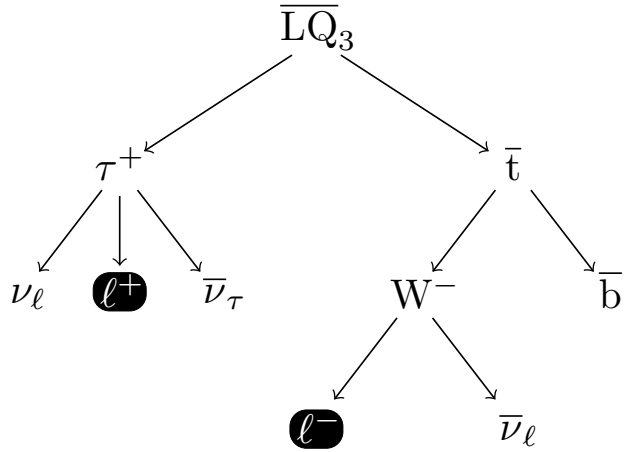


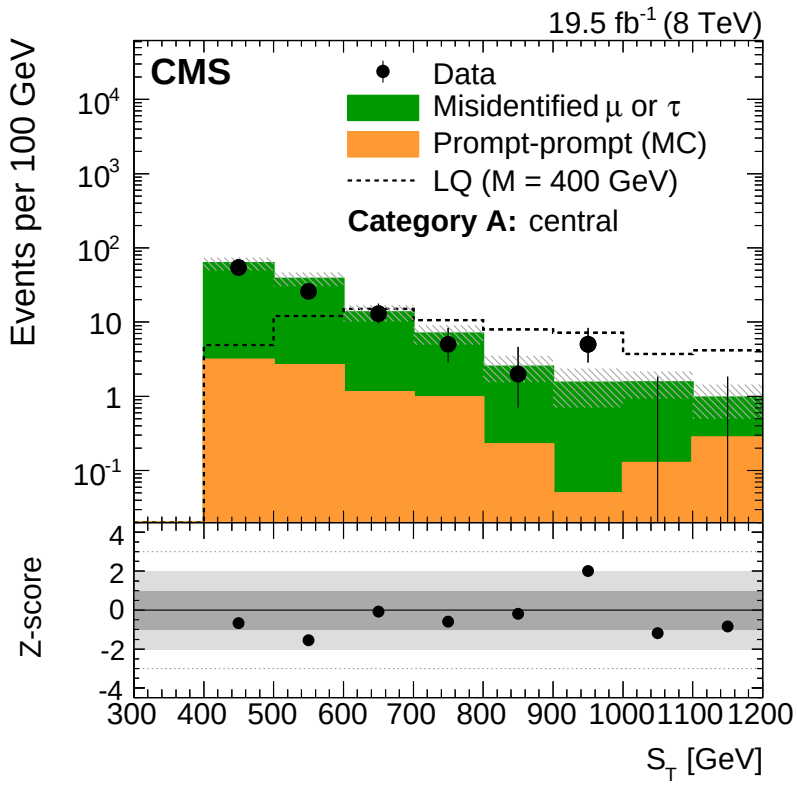


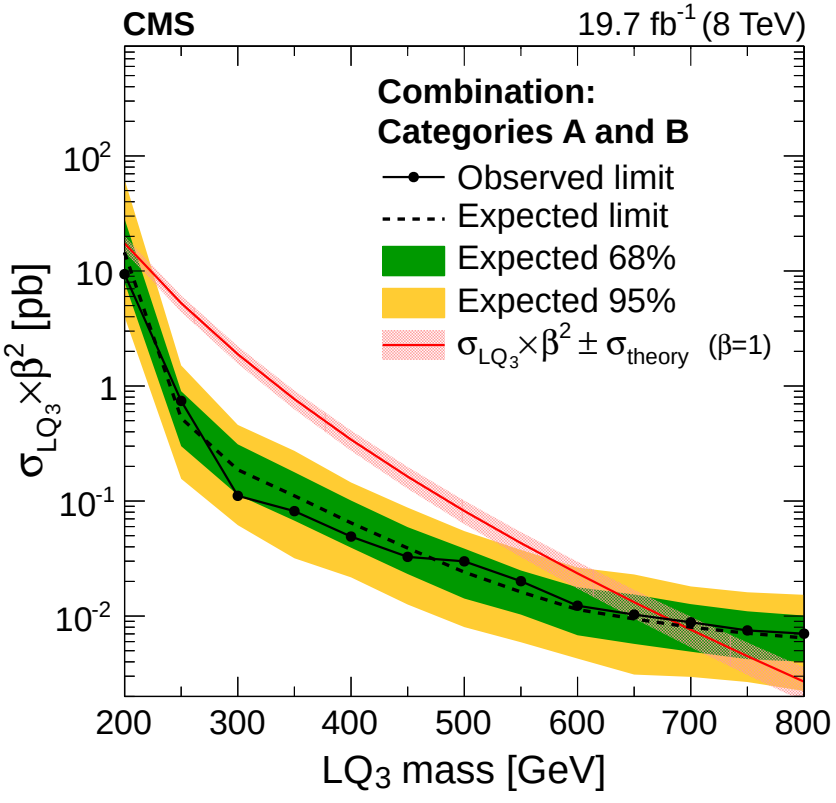
EXO-16-006

Results: 3rd generation leptoquarks



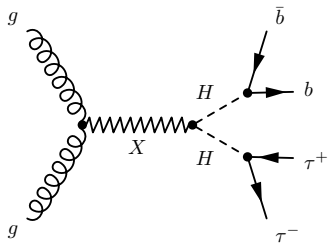


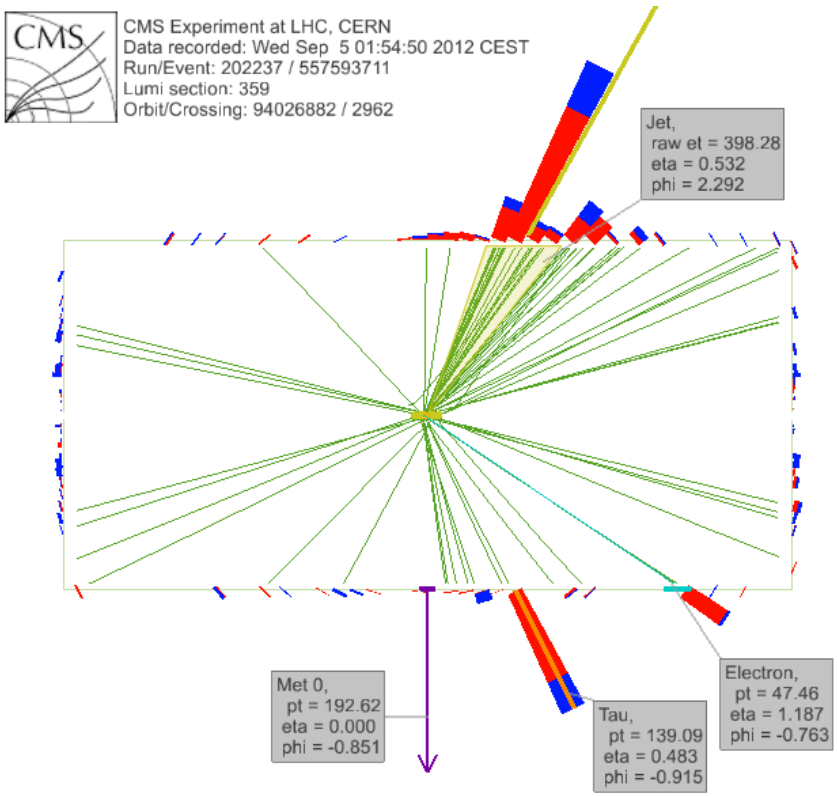


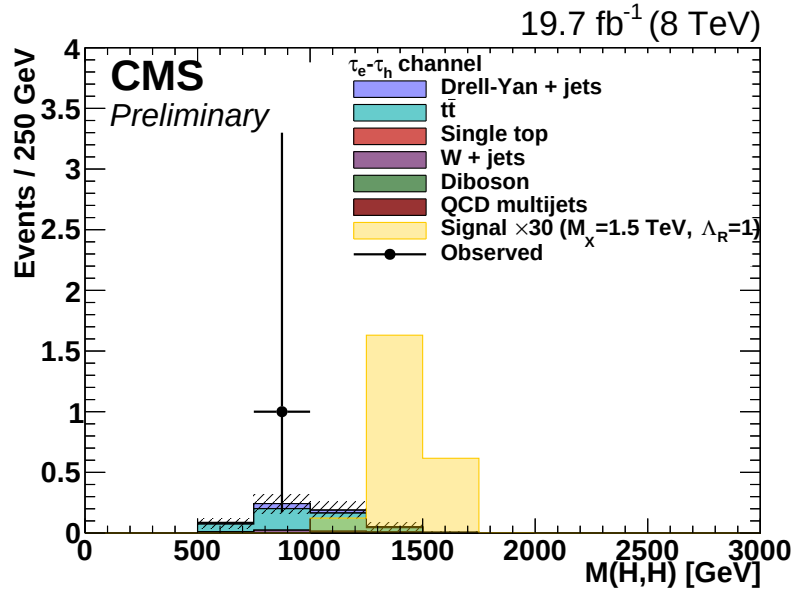


EXO-14-008

Results: $X \to h_{125}\, h_{125} \to b\bar{b}\, \tau^+\tau^-$

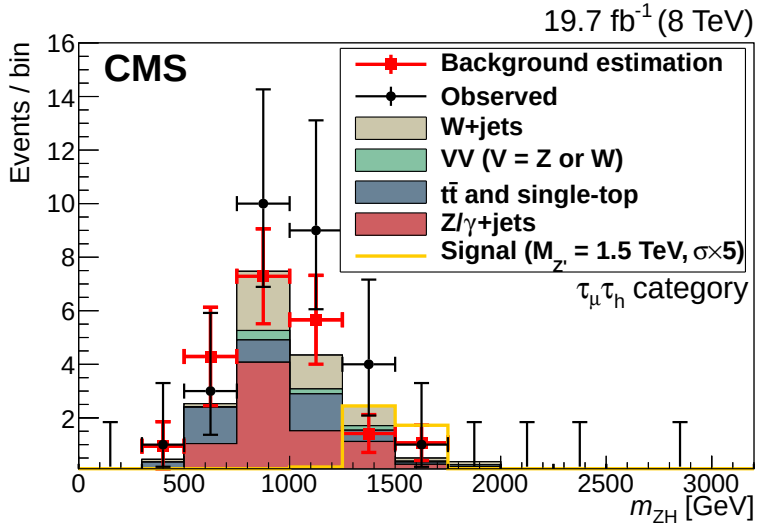


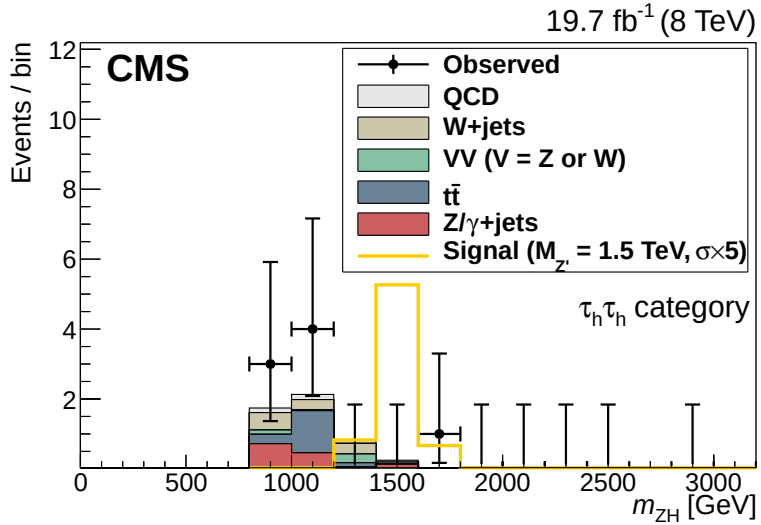


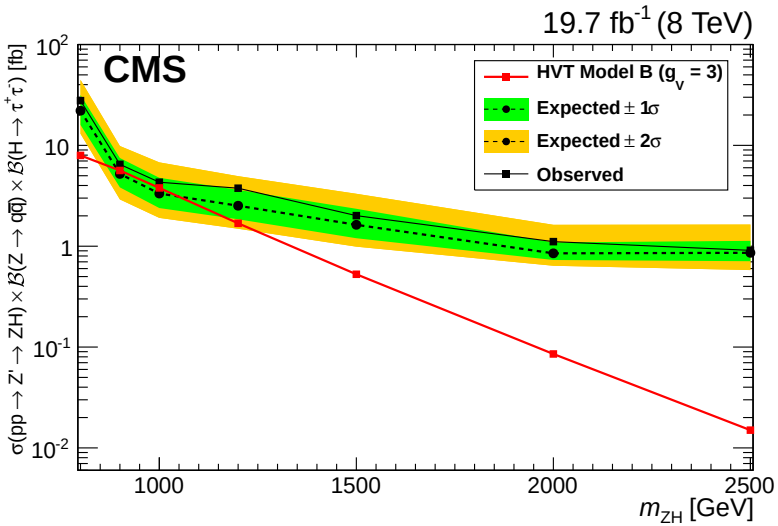


EXO-15-008 (see also HIG-14-034, HIG-15-013, HIG-16-013)

Results: $Z' \rightarrow HZ$

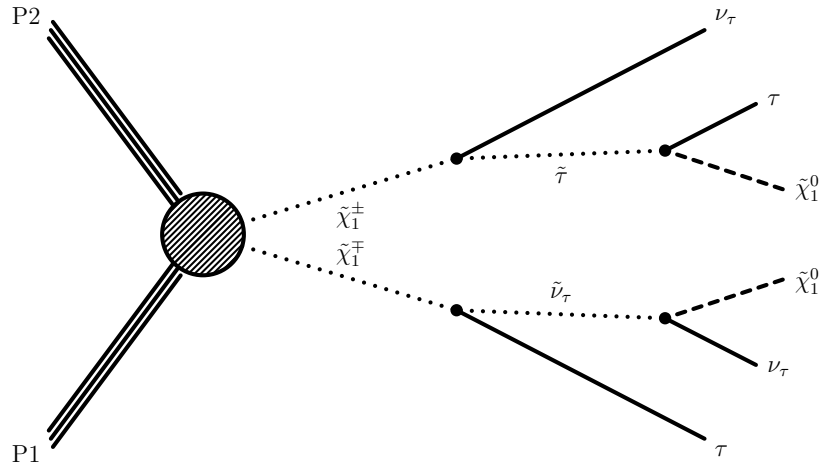


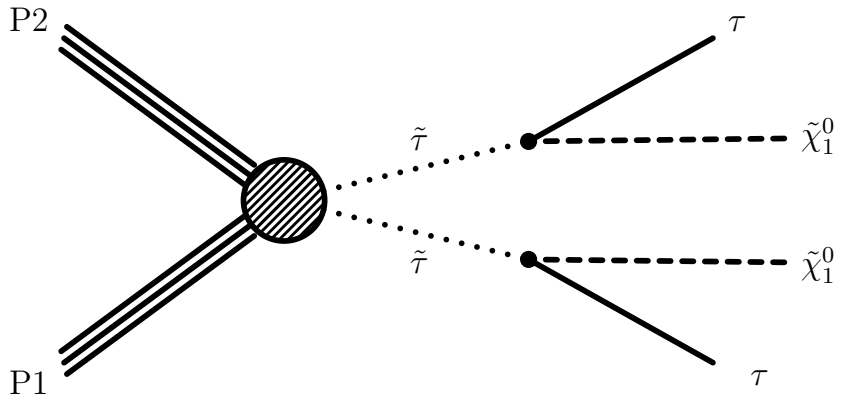


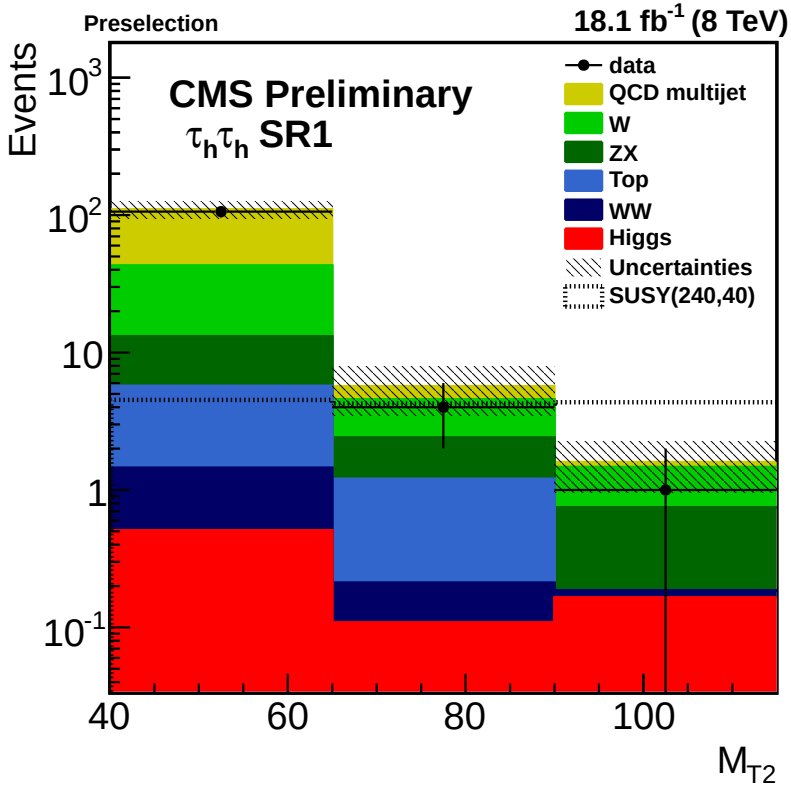


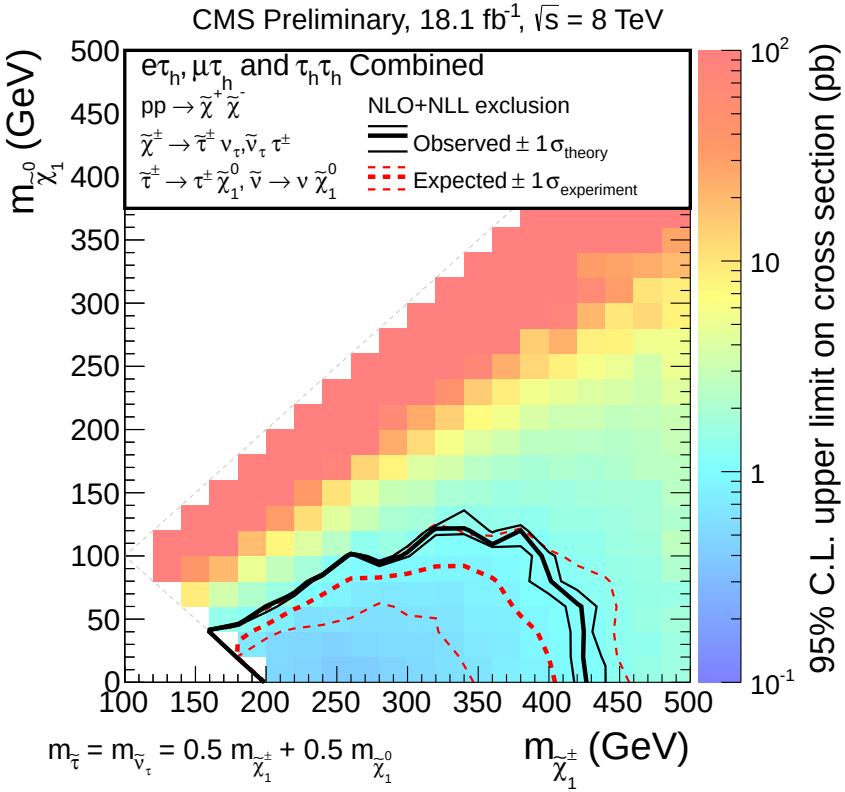
EXO-13-007

Results: chargino/stau pair production



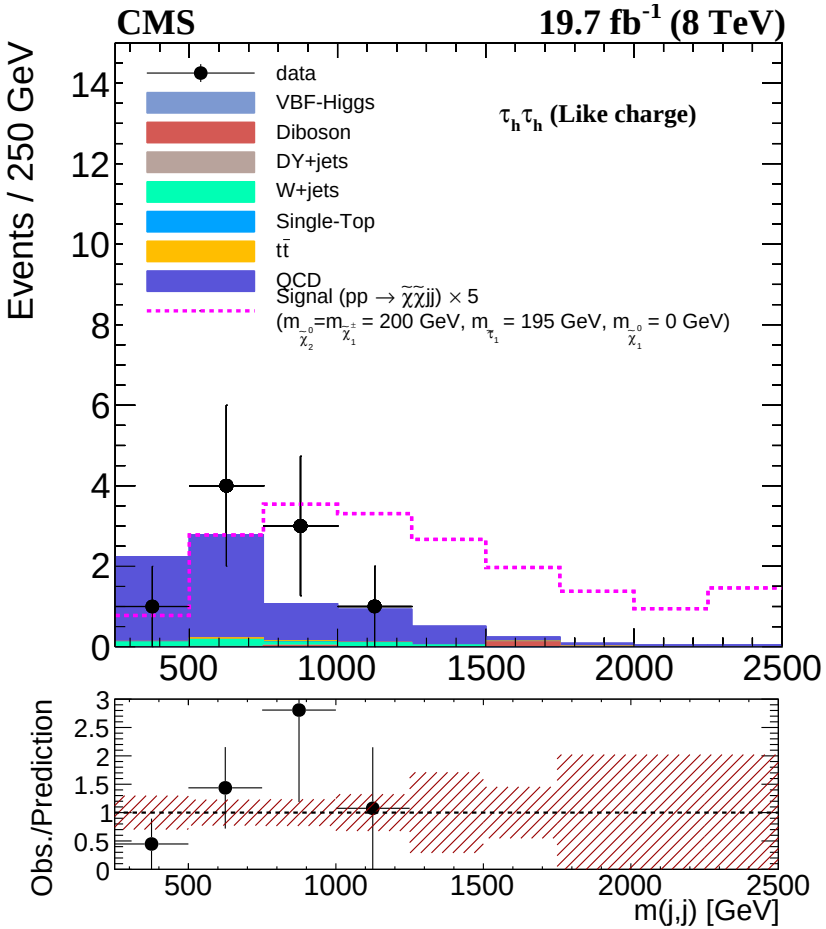


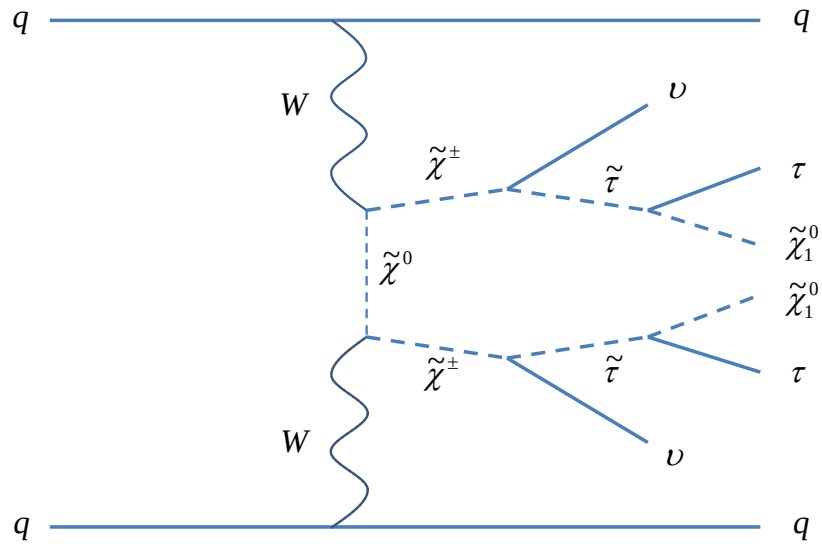


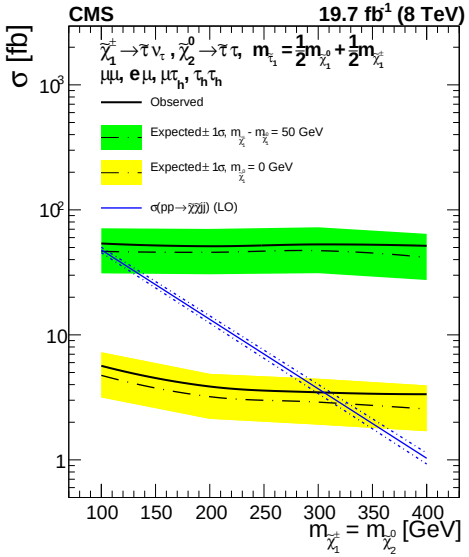


SUS-14-022

Results: taus via SUSY VBF







SUS-14-005

Summary

- Investments in τ trigger and reconstruction continue to pay off
- Many exciting search results from 8 and 13 TeV runs
- Additional 13 TeV results coming soon!