Search for scalar top quark pair production in the top corridor region with CMS

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ICTEA

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MOTIVATION

- The **stop quark** plays an essential role in understanding the SUSY models.

- Several searches with the full **Run 2 dataset** have been performed by the CMS Collaboration excluding stop masses up to 1.2 TeV, but most of these searches are not sensitive in the so-called "top corridor".

  • All jets: *Eur. Phys. J. C 80 (2020) 3*, *JHEP 10 (2019) 244*

  • Lepton + jets: *JHEP 05 (2020) 032*

  • Dileptons: *CMS-PAS-SUS-19-011*, *JHEP 03 (2019) 101**(top corridor)

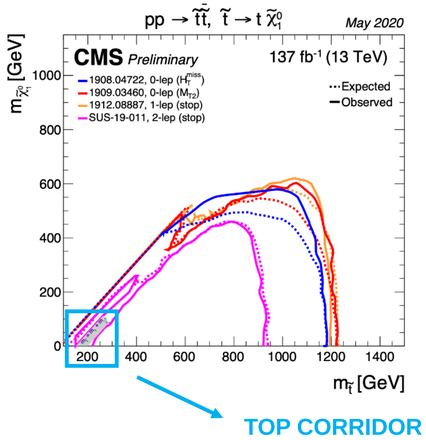

Fig 2. Summary of the exclusión limits obtained with full Run 2 dataset by the CMS Collaboration. The gray band on the bottom corresponds to the top corridor region, which is still blanched.

- The mass difference between stop and neutralino is close to the **top mass**.
- Signal and $t\bar{t}$ background have **similar kinematics**, especially at low neutralino masses.
- Signal events can only be detected as an **excess on the $t\bar{t}$ cross section**.
- The **accurate estimation of $t\bar{t}$** process is very important to have sensitivity.

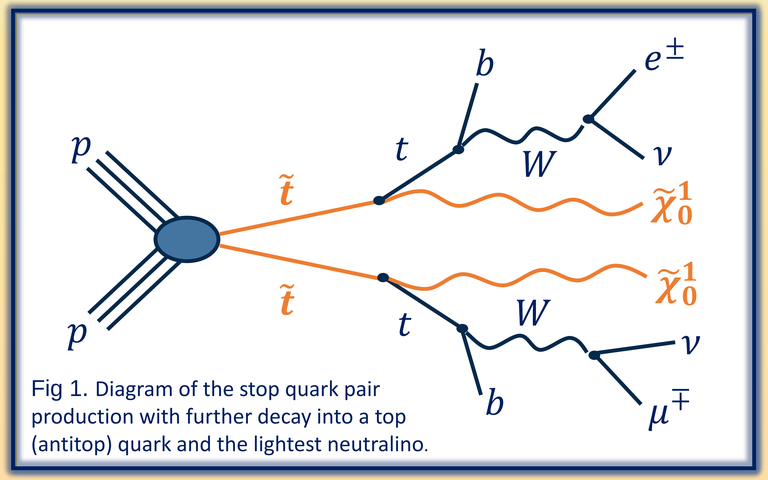

Fig 1. Diagram of the stop quark pair production with further decay into a top (antitop) quark and the lightest neutralino.

METHODOLOGY

Event selection and strategy

- **2016 dataset** is used, corresponding to an integrated luminosity of 35.9 fb^{-1}.
- Opposite-sign eμ pair, $N_j \geq 2$ and $N_b \geq 1$.
- Search for degenerate stop pair production in 3 diagonals:

$$\Delta m(\tilde{t}, \tilde{\chi}_0^1) = m_t, m_t \pm 7.5\ GeV$$

- Main discriminating variable: $\mathbf{M_{T2}(e\mu)}$

$$M_{T2}(e\mu) = \min_{\vec{p}_{T,1}^{miss}+\vec{p}_{T,2}^{miss}=\vec{p}_T^{miss}} (\max[m_T(\vec{p}_T^{l1}, \vec{p}_{T,1}^{miss}), m_T(\vec{p}_T^{l2}, \vec{p}_{T,1}^{miss})])$$

The $\boldsymbol{M_{T2}}$ **variable** has an endpoint for $t\bar{t}$ at the W boson mass, so signal events are expected to populate the tails of the distribution.

Backgrounds

Main background is $\boldsymbol{t\bar{t}}$ due to the similar kinematics with the signal process in this region. It is estimated from MC with an **accurate knowledge** to have sensitivity.

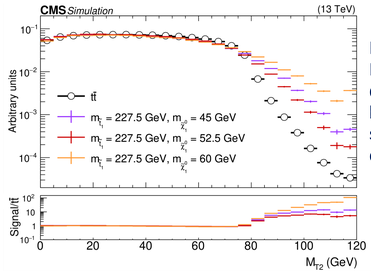

Fig 3. Normalized $\boldsymbol{M_{T2}}$ distribution for $\boldsymbol{t\bar{t}}$ in black and three signal models in other colours.

RESULTS

No excess is observed and for the signal extraction the $\boldsymbol{M_{T2}}$ distribution is used.

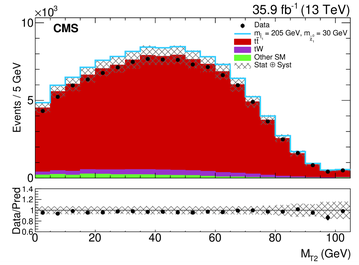

Fig 4. Data/MC agreement of the $\boldsymbol{M_{T2}}$ distribution.

Results are presented in terms of **exclusion limits** at 95% confident level for stop quark pair production on simplified models of SUSY. Stop masses excluded up to:

- **m($\tilde{t}_1$) > 208 GeV for Δm = 175 GeV.**
- **m($\tilde{t}_1$) > 235 GeV for Δm = 175 - 7.5 GeV**
- **m($\tilde{t}_1$) > 242 GeV for Δm = 175 + 7.5 GeV**

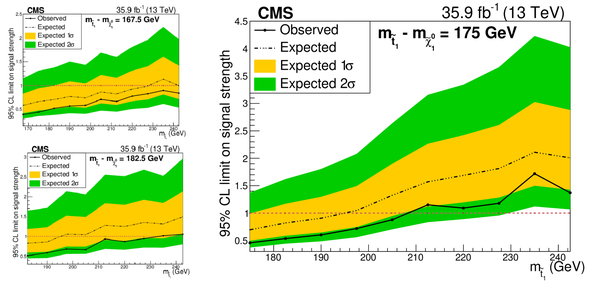

Fig 5. Exclusion limits in the three main diagonals of the top corridor.

This result significantly extends the exclusion limits of stop quark searches at the LHC to higher stop masses in this region, that was previously unexplored.

REFERENCES

CMS Collaboration, "Search for the pair production of light top squarks in the $e\mu$ final state in proton-proton collisions at $\sqrt{s}$= 13 TeV", JHEP **03** (2019) 101, doi:10.1007/JHEP03(2019)101