Prospects to exclude top quark partners using Run II and HL-LHC data sets

Current efforts in CMS to exclude new physics in $t\bar{t}$ production using Run2 data (in the form of $t\bar{t} + \text{DM}$) and at the HL-LHC (in form of anomalous couplings of the $ttZ$ vertex) are reviewed. A projection study of the sensitivity in the SUSY top-corridor and DM at the HL-LHC using top quark properties is also proposed.
Astrophysical observations provide evidence of dark matter (DM).

Assuming the DM candidate particle respects minimal flavor violation, it should interact preferentially with third generation quarks.

A potential dark matter signal should be observed as an excess of events (relative to the background) at high missing transverse energy.
**Results**

Data are found to be in **agreement** with the expected **Standard Model** background in the signal region.

Mediator masses below 290 (scalar) and 300 (pseudo-scalar) GeV (and above 10 GeV) are excluded at a 2σ confidence level.

**t\bar{t} + X at the HL-LHC**

Many new physics model predict **anomalous couplings** of the top to electroweak gauge bosons.

Effective field theories offer a useful framework for indirect probes of new physics at higher energy scales.

\[ \mathcal{L} = \mathcal{L}_{SM} + \sum_i \frac{c_i}{\Lambda^2} \mathcal{O}_i + \cdots \]
**Analysis strategy**

EFT operator $C_{tZ}$ can be constrained using properties such as the relative angle of the negatively charged lepton in the Z boson rest frame.

**Results**

Signal region yields in the HL-LHC scenario (above) and profiled likelihood ratio for $C_{tZ}$ under the SM only hypothesis.
Outlook

Use precision top quark properties such as the spin polarization and correlations to constrain new physics in top pair production

\[ \frac{1}{\sigma} \frac{d^2\sigma}{d\cos \theta_1^t d\cos \theta_2^\bar{t}} = \frac{1}{4} \left( 1 + B_1^i \cos \theta_1^i + B_2^j \cos \theta_2^j - C_{ij} \cos \theta_1^i \cos \theta_2^j \right) \]

\( B_{1/2}^i \) refer to the spin polarizations of the top/anti-top. \( C_{ij} \) refer to elements of the \( t\bar{t} \) spin correlation matrix.

Currently working on SUSY top corridor and \( t\bar{t} \) + DM phase space constraints using dilepton events for an upcoming study for the HL-LHC.

Similar to SUS-20-001 but uses top properties instead of kinematic variables.