

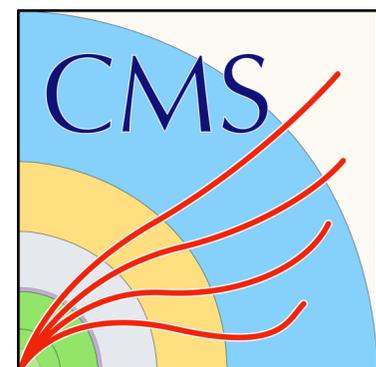
LHCP2021

The Ninth Annual Conference on Large Hadron Collider Physics

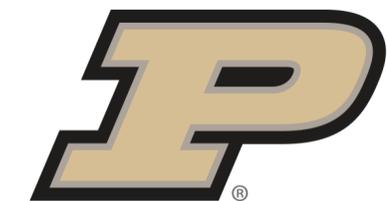
7-12 June 2021 Paris (France), Sorbonne Université (IN2P3/CNRS,IRFU/CEA)

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 $t\bar{t}Z$ 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.

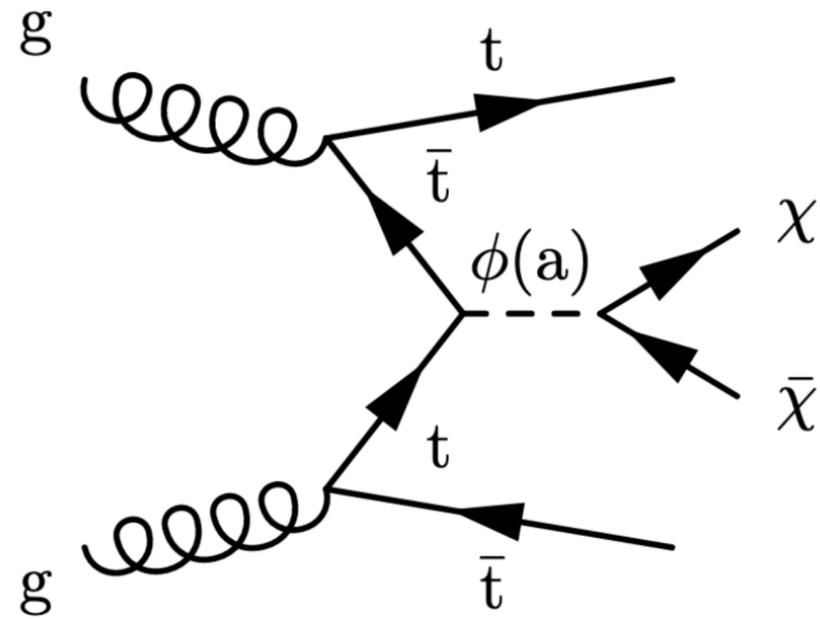


Amandeep Singh Bakshi, on behalf of the CMS Collaboration
Purdue University



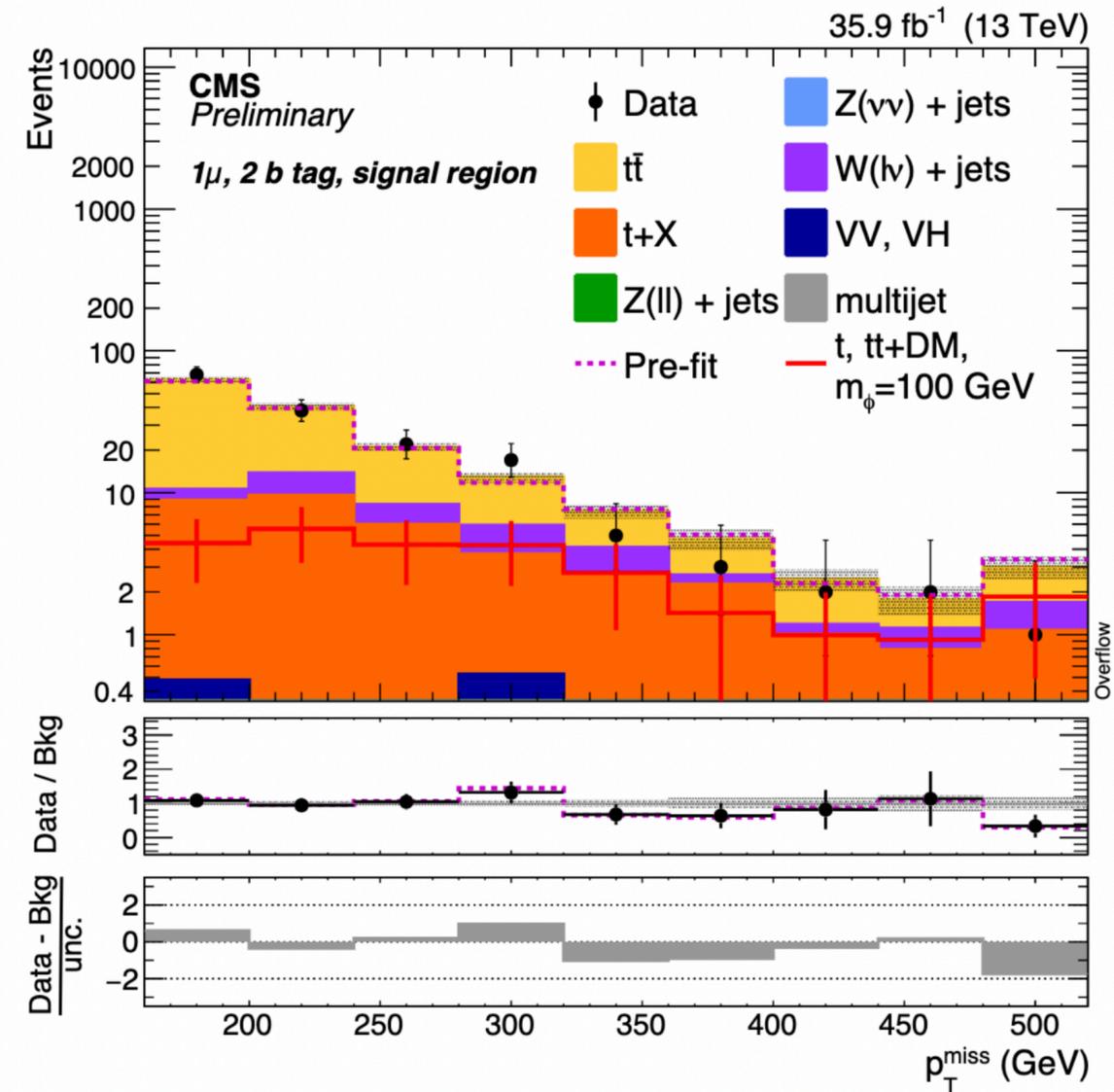
$t\bar{t}$ + DM with Run 2 data

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](#).

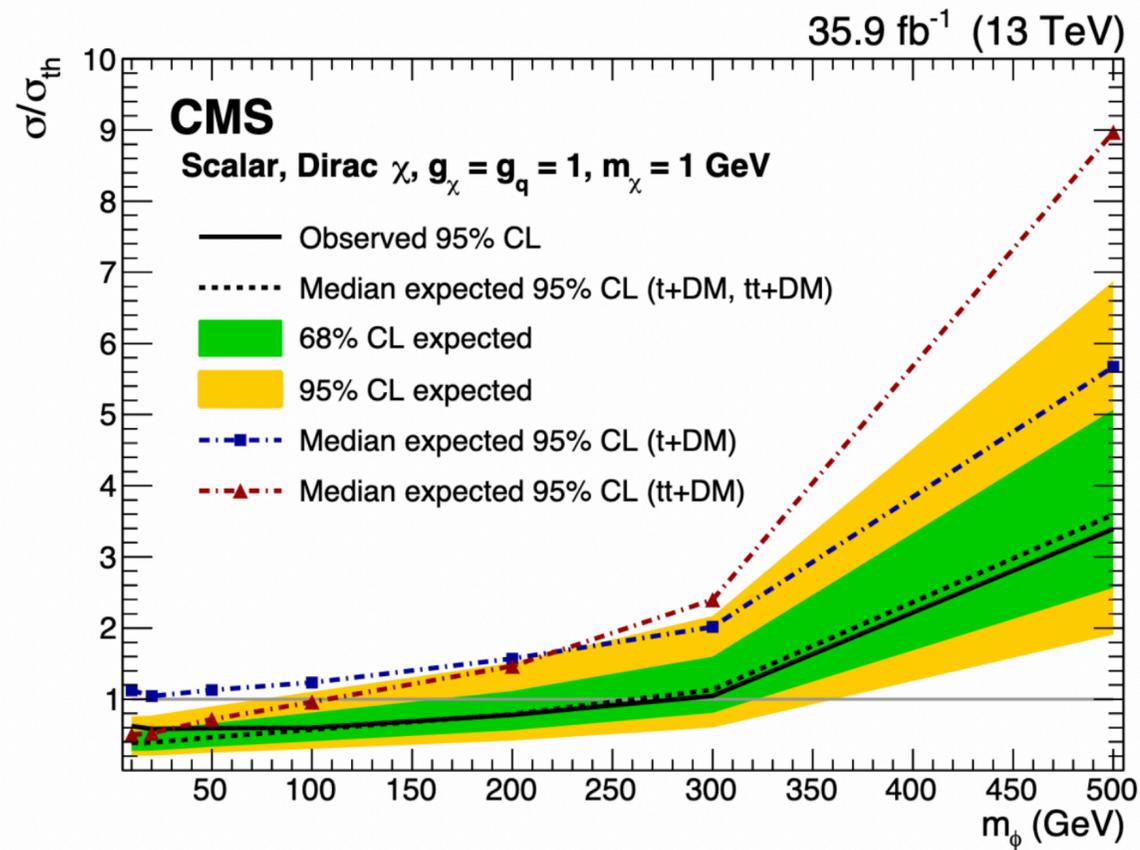
Analysis strategy



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

Results

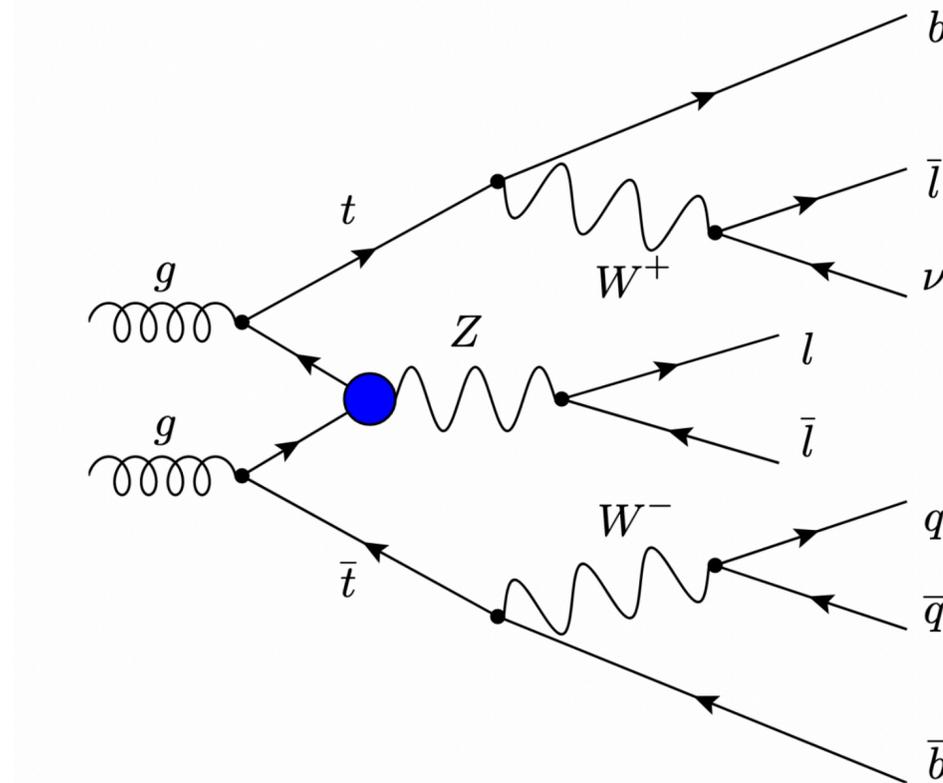
Data are found to be in **agreement** with the expected **Standard Model** background in the signal region.



Mediator masses below **290 (scalar)** and **300 (pseudoscalar) 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

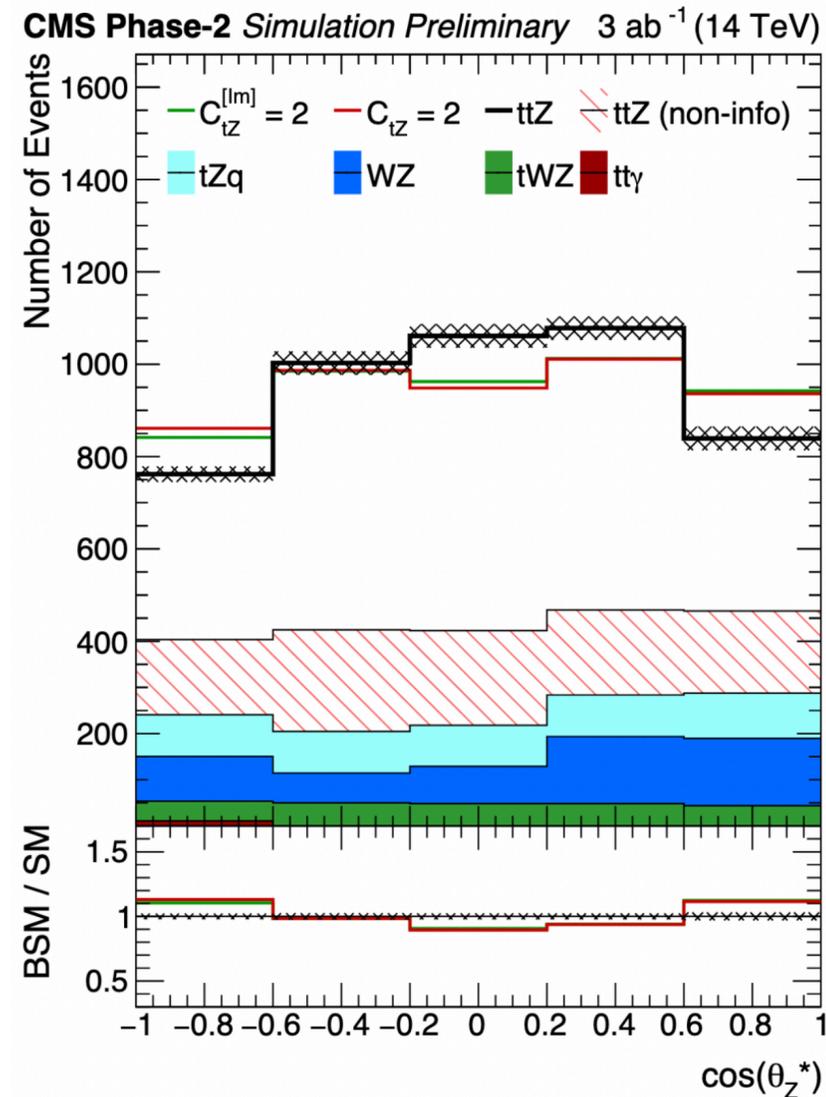


Effective field theories offer a useful framework for indirect probes of new physics at higher energy scales.

$$\mathcal{L} = \mathcal{L}_{SM} + \sum_i \frac{c_i}{\Lambda^2} \mathcal{O}_i + \dots$$

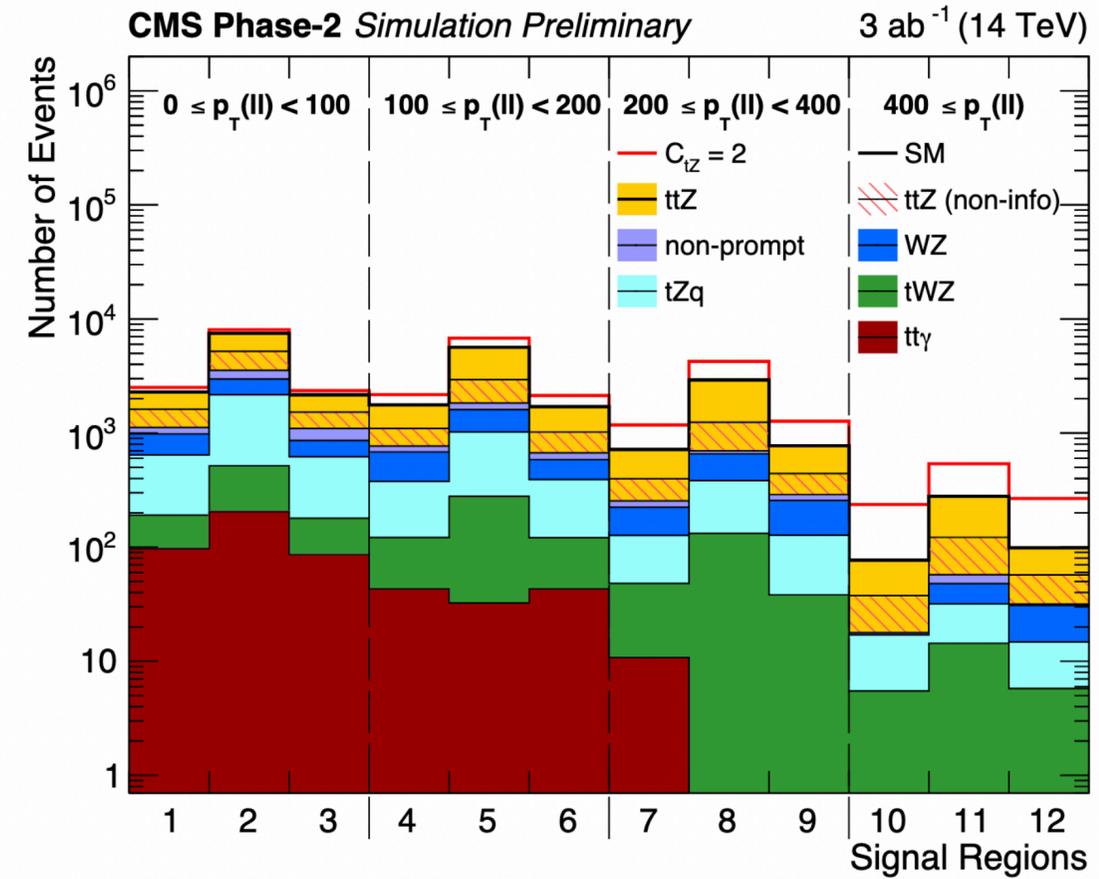
Analysis strategy

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.



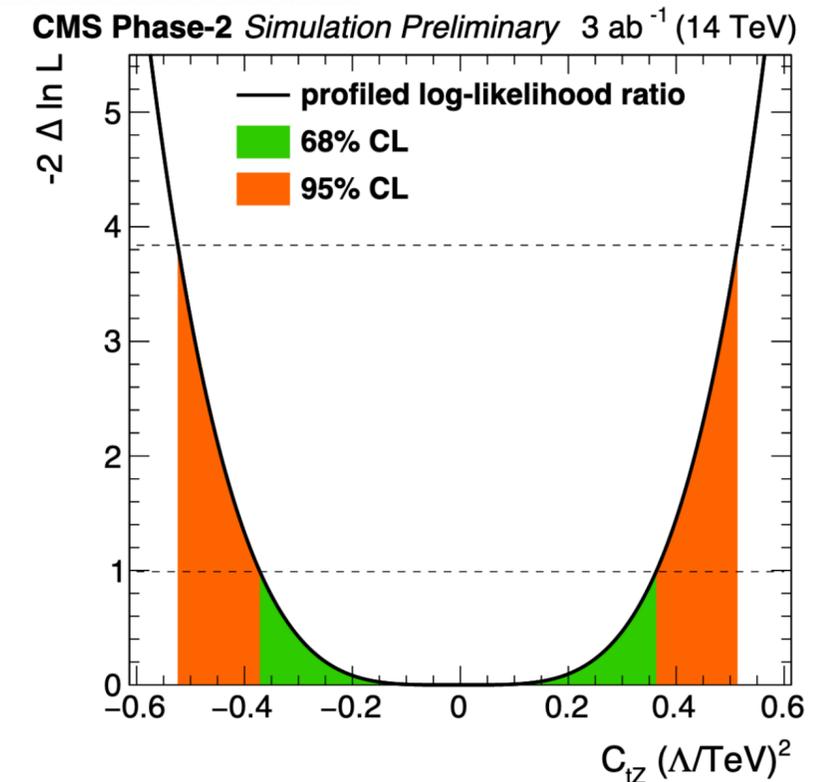
CMS Collaboration FTR-18-036-PAS

Results



CMS Collaboration
FTR-18-036-PAS

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

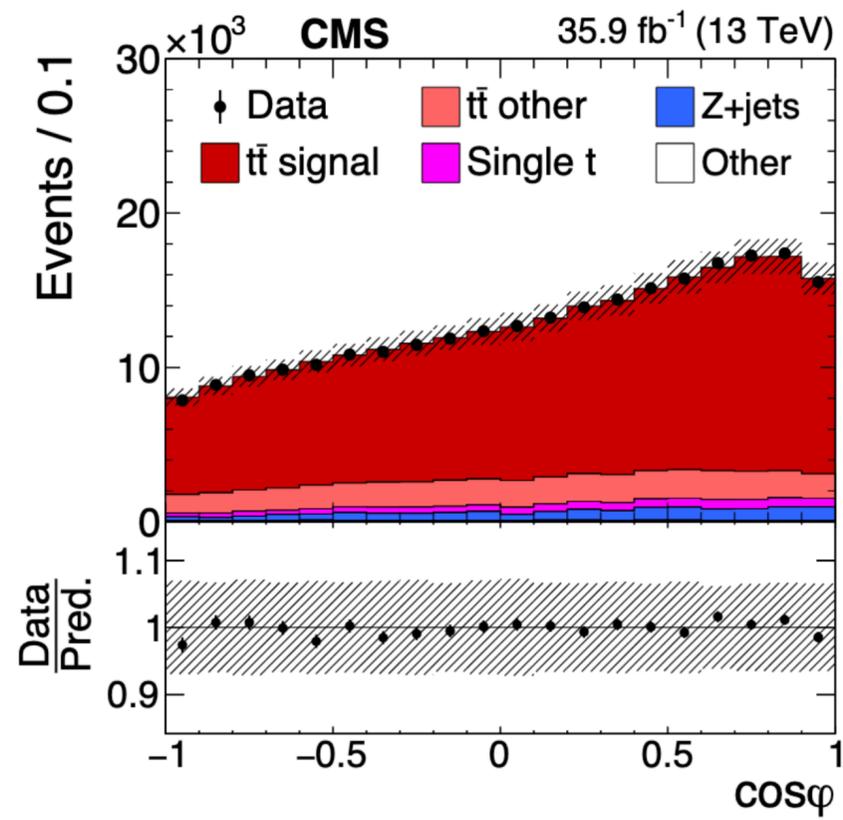
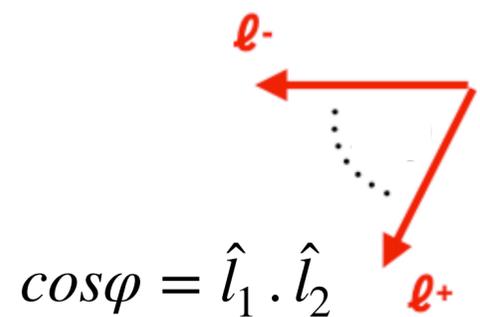


Outlook

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

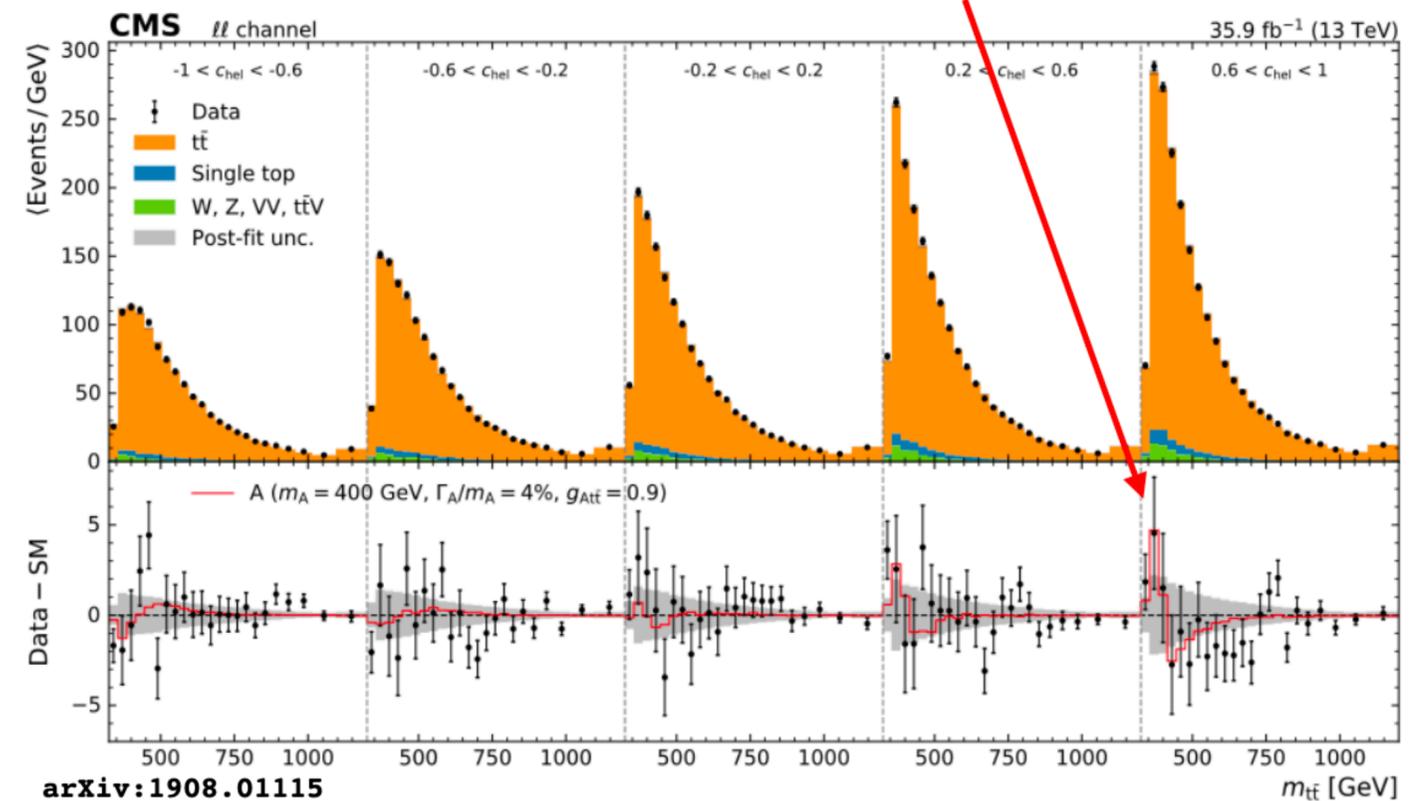
$$\frac{1}{\sigma} \frac{d^2\sigma}{d\cos\theta_1^i d\cos\theta_2^j} = \frac{1}{4} \left(1 + B_1^i \cos\theta_1^i + B_2^j \cos\theta_2^j - C_{ij} \cos\theta_1^i \cos\theta_2^j \right)$$

$B_{1/2}^i$ 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**.

pseudoscalar, $m_A=400$ GeV, $\Gamma_A=0.04 \cdot m_A$



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