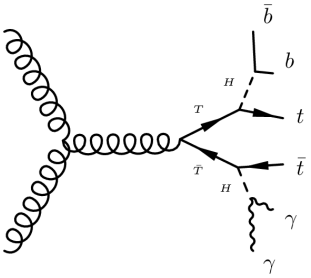
ICHEP 2014 – Valencia

Search for pair production of vector-like partners of the top quark (T), with T → tH, H→ γγ

- The discovery of a Higgs boson at the LHC sets **constraints on a simple sequential fourth generation** of quarks
- Still, the presence of **new physics** is **necessary to stabilize** its **mass**
- **Fermionic vector-like top quark** partners would achieve that, avoiding the fine-tuning problem
- The precise knowledge of the Higgs boson mass now allows to **target the T → tH** decay

T quark pair production and decay chain

- **strong interaction** involved:
  huge cross-sections allow the possibility to exploit the H→γγ channel
  - one T decays in tH, **H→γγ**
  - no constraints on the other one (it can decay in tH,tZ or bW)



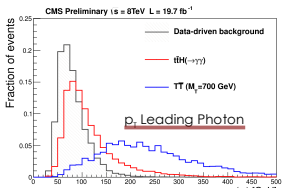
H→γγ advantages:
- **Data driven background** estimation: fit to $M_{\gamma\gamma}$ spectrum

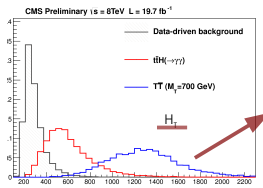
Final state signature:
- Two **energetic photons**
- **High jet multiplicity**
- High b-jet multiplicity
- Leptons

Reconstructed objects:
- **Photons:** same ID of H→γγ analysis
- **Jets:** p_T > 25 GeV and $|\eta|$ < 2.4 (tracker acceptance)
- **Leptons:** p_T > 20 GeV

Selection

- **2 categories**, depending on the presence of leptons in the final state: Hadronic and Leptonic
- **2 types of backgrounds:**
  resonant in $M_{\gamma\gamma}$ (ttH, H→γγ) and
  non resonant in $M_{\gamma\gamma}$ (diphoton + jets, tt + γγ, t + γγ , tt + jets)





Final state objects carry higher p_T wrt backgrounds (ttH and non-resonant one)

$H_T = \Sigma_{objects} p_T$

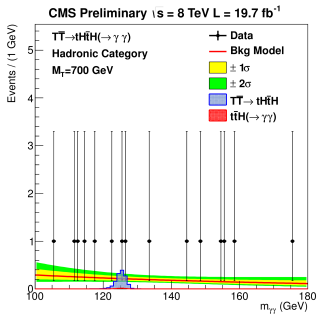
	Hadronic	Leptonic
$p_T(\gamma_1)$	> ¾ $M_{\gamma\gamma}$ GeV	> ½ $M_{\gamma\gamma}$ GeV
$p_T(\gamma_2)$	> 35 GeV	> 25 GeV
H_T	> 1000 GeV	> 770 GeV
# b-Jets	≥ 1	-
Leptons (e/μ)	0	≥ 1

Final state objects are boosted for the signal: we can set higher p_T cuts

H_T requirements allow **looser cuts on # b-Jets**

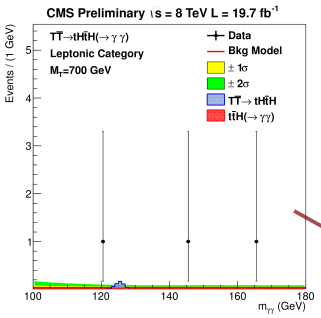
Results with 19.7 fb^{-1} @ 8 TeV: M_T = 700 GeV

Hadronic



Observed limit: 0.25 pb
Expected limit: 0.16 pb

Leptonic



Observed limit: 0.29 pb
Expected limit: 0.27 pb

Exponential fit for both category

Very **pure** category: only 3 events in data sidebands

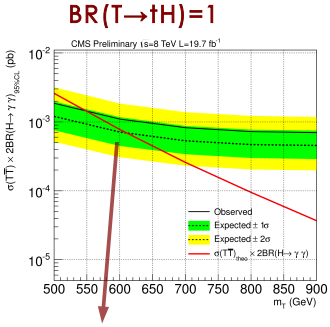
Main Systematics:

(but with low impact on the limits)
- **Luminosity:** 2.6 %
- **Theoretical uncertainties:** 4-9 %
  QCD scale, PDF uncertainty
- **Photon reconstruction:** ~ 3-4 %
  Shape uncertainties on energy resolution, scale and ID efficiency
- **Jet energy corrections:** 1-7 %
  Estimated varying 1 σ up/down JES and JER on MC

Process	Hadronic	Leptonic
TT(M_T=700 GeV)	1.05	0.43
ttH	0.042	0.039
Background	$0.65^{+0.16}_{-0.13}$	$0.11^{+0.07}_{-0.03}$
Obs. Data	2	0

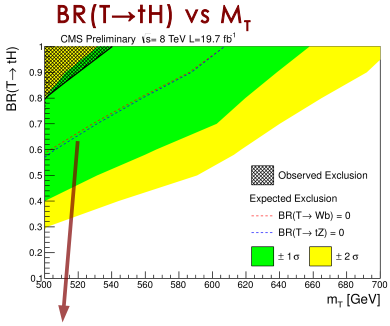
Statistical interpretation

BR(T→tH)=1



Mass range exclusion:
Observed: 540 GeV
Expected: 607 GeV

BR(T→tH) vs M_T



Results only sensitive to **BR(T→tH)**

Conclusion

- First search for pair production of T quarks, with T → tH, H→γγ
- No significant excess over background-only hypothesis
- For **BR(T→tH)=1**:

  Observed (Expected) **exclusion: 540 (607) GeV**
- **Results extended** to other possible sets of BRs
- Reference: **CMS-B2G-14-003**

Giuseppe Fasanella, "ULB" Université Libre de Bruxelles and "Sapienza" Università di Roma