Search for monotops at the LHC

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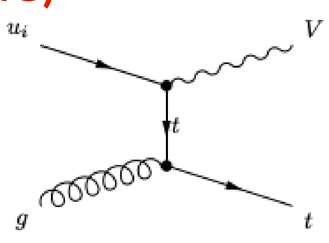
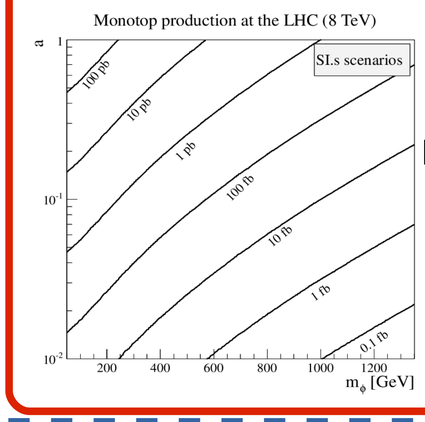
Theoretical context[1]

Monotop = top + missing transverse energy (MET)
Monotop production modes via an **effective theory**

Flavor Changing Neutral Current (FCNC)

V: vector invisible BSM particle (**DM candidate**)

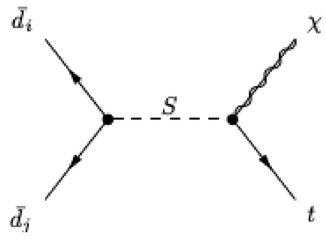




Free parameters :

- **a** : coupling strength
- **m_φ**: mass of the DM candidate

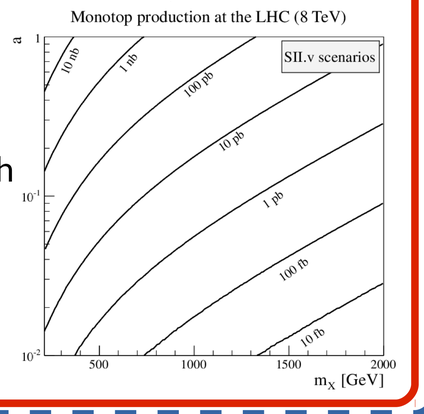
Resonance



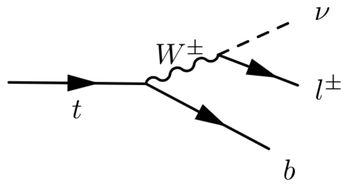
S: scalar BSM mediator
χ: fermionic invisible BSM particle (**DM candidate**)

Free parameters :

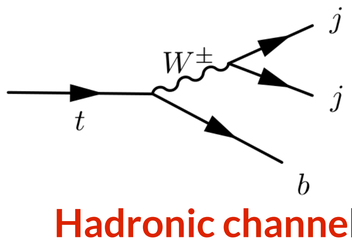
- **a** : coupling strength
- **m_φ**: mass of the DM candidate
- **m_χ**: mass of the resonant particle



Both hadronic and leptonic top decays considered



Leptonic channel



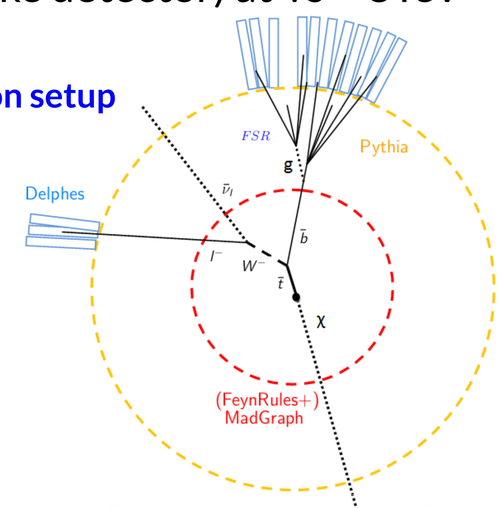
Hadronic channel

Phenomenology[1]

Delphes fast **simulation** (CMS-like detector) at √s = 8TeV assuming 20 fb^{-1} of collisions.

MC-based simulation setup

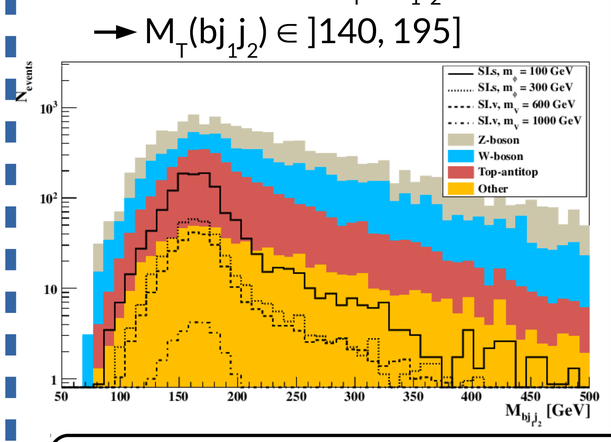
1) Hard process generated at Leading Order (LO).
2) Partons showered and hadronized.
3) Detector effects accounted for.



Hadronic channel

Event selection

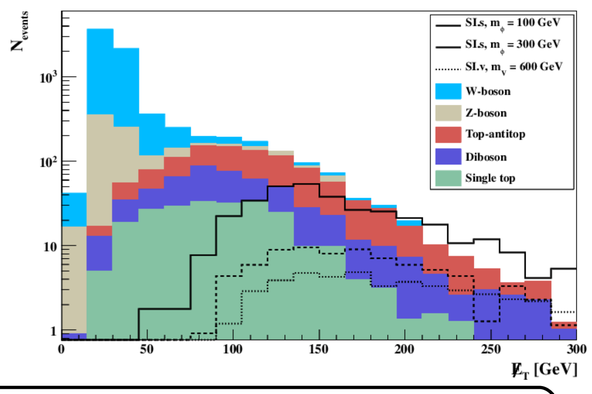
- **Jets :** 2 or 3 lights, 1 b-tagged
- Veto on isolated e,μ
- $M_T(W) \in]50, 105[$ GeV
- Missing E_T > 150 GeV
- **Top mass reconstruction (bj_1j_2)**
  → $\Delta\varphi$ (missing p_T - bj_1j_2) ∈]1,5[
  → $M_T(bj_1j_2) \in]140, 195]$



Leptonic channel

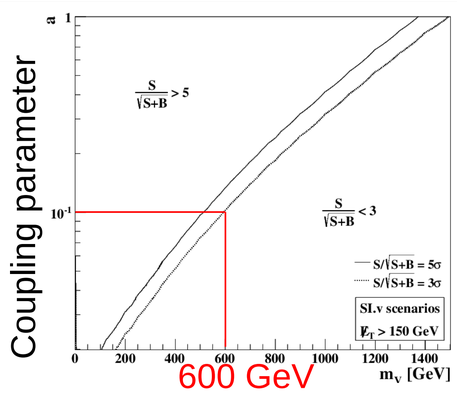
Event selection

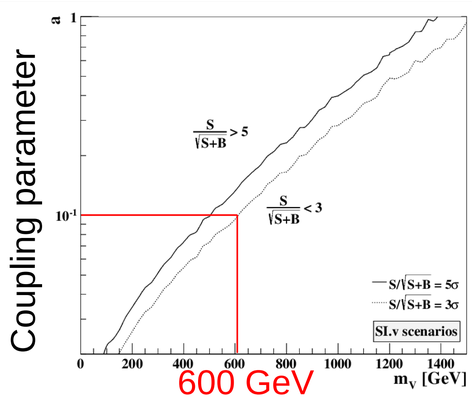
- 1 muon or electron
- **Jets :** 1 b-tagged
- P_T (leading jet) > 75 GeV
- $M_T(W)$ > 115 GeV
- Cut on missing E_T optimized per benchmark



Sensitivity criteria

- **Significance** $s = \frac{S}{\sqrt{S+B}}$ is used to probe the sensitivity.
- S (resp. B) is the number of signal (resp. background) events surviving the selection.
- s = 3 (resp. s = 5) contour lines are related to a 3σ observation (resp. 5σ discovery) of a monotop hint at the LHC.





Interpretation : vector DM candidates with masses **below 600 GeV** can be excluded even with a moderate coupling strength a = 0.1 **for both channels**.

Search[2] @ 8 TeV

Hadronic channel with 19.7 fb^{-1} of pp collisions at √s = 8TeV.

Online trigger : MET > 150 GeV

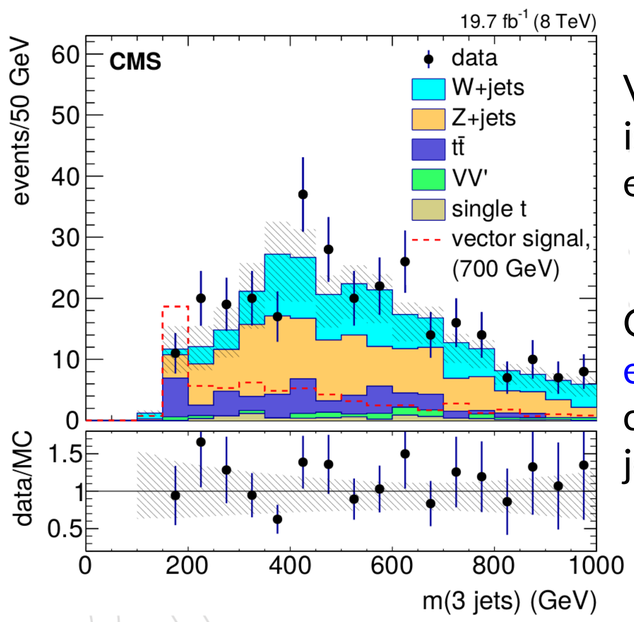
Event selection

- **Jets :** p_T (3 leading jets)> 60,60,40 GeV with one b-tagged
- Veto on event with isolated (iso < 0.2) muon or electron
- $M(bj_1j_2)$ < 250 GeV
- Missing E_T > 350 GeV

Main backgrounds

- $t\bar{t}$ } where a charged lepton from the W decay fails the selection or the detection.
- W+ jets }
- QCD where mis-reconstructed jets induce large missing E_T.
- Z + jets where the Z boson decays into a pair of neutrinos.

Results

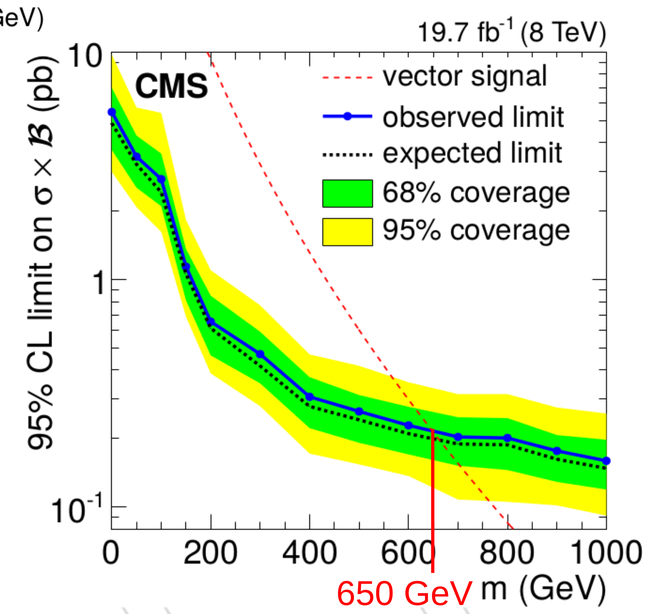


V+jets background contamination is estimated from data in its μ-enriched region.

QCD-multijets background is also estimated from data using a control region with zero b-tagged jets.

Remaining backgrounds are then compared to the data in a region where the signal is expected to live.

A cut&count experiment is proceeded to set limits at 95 % Confidence Level (CL).



Interpretation : vector DM candidates with masses **below 650 GeV** are excluded **for hadronic channel** (with a = 0.1).

References :
[1]J.-L. Agram et al., 'Monotop phenomenology at the LHC', *Phys. Rev.* **D84** (2011) 074025
[2]CMS Collab., 'Search for new physics with monotop final states in pp collisions at √s = 8 TeV', arXiV:1410.1149 (2014)