Implications of LHC results for TeV scale Physics

WG3: “Everything else” (that is not directly related to EWSB or $\not{E}_T$)

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Structure of the WG (i.e. document)

- Top-like new physics and boosted techniques
- New fermions
- New bosons (mainly vectors, maybe also scalars?)
- Long-lived particles
- Exotic exotics
- Flavor (almost a separate WG, maybe separate document?)

What we heard this week

- Experimental talks:
  - Updated results from Moriond
  - Many different analyses/final states considered
  - Many with full (or close) luminosity

2.1) Search for EW like models: Z'

- 7 TeV program: CMS tend the full coverage of Z' searches in all final states.
  - explore all channels = reduce model dependence.
    = reduce experimental uncertainties dependence.
  - there are always models tailored to a given channel:
    fermiophobic Z', Z' as tt resonant states...

Channel	Analysis	Lumi
Leptons : ee, μμ	EXO-11-019 : Dilepton bump search	4.7 fb^{-1}
Leptons : ττ		
Quarks : qq - jet-jet	EXO-11-015 : Dijet bump search 10.1016/j.PhysLetB.2011.09.015	1.0 fb^{-1}
Quarks : bb - jet-jet		
Quarks : tt	EXO-11-006* : Full hadronic PAS TOP-11-009* : Semi leptonic PAS EXO-11-055* : Semi leptonic μ PAS EXO-11-092* : Semi leptonic e	4.6 fb^{-1} 4.9 fb^{-1} 1.1 fb^{-1} 4.7 fb^{-1}
Bosons : ZZ, WW		

Maxime Gouzevitch

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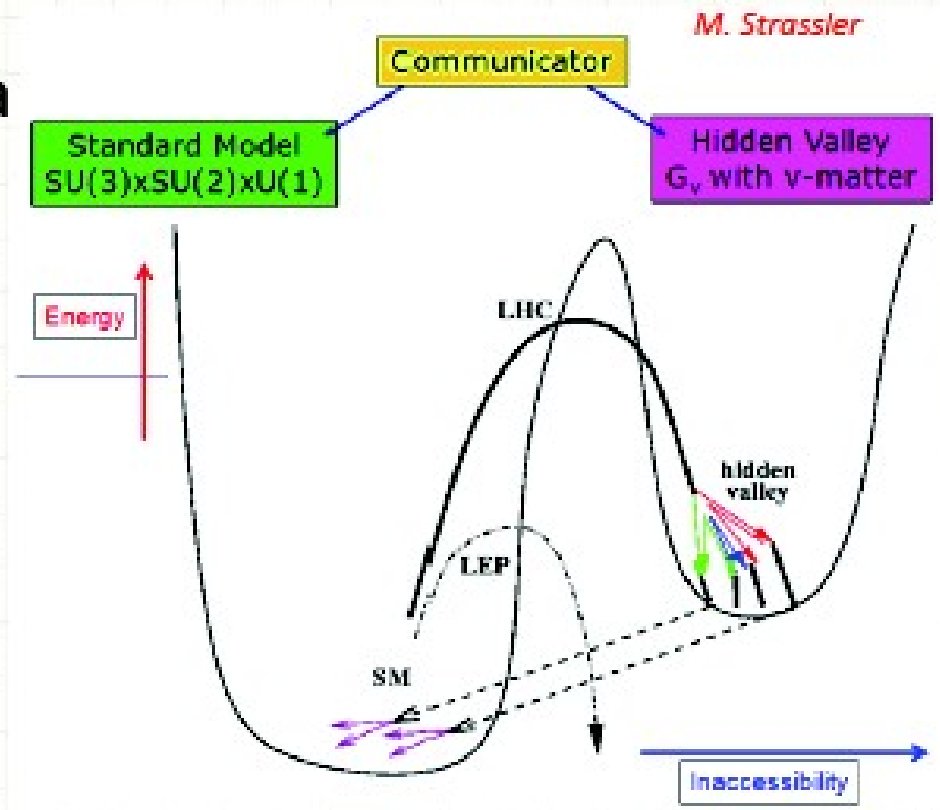
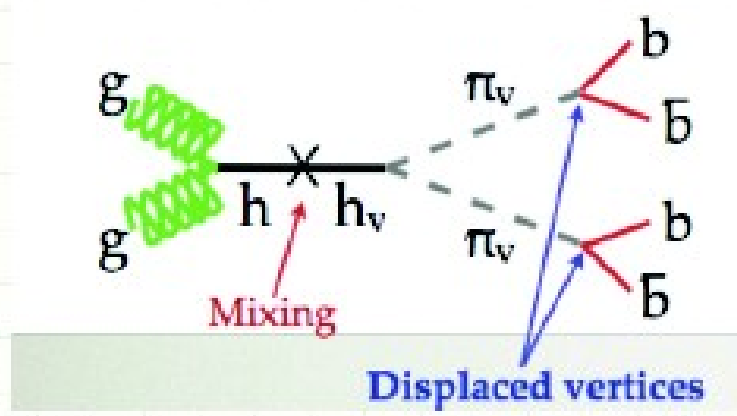
Long-Lived Particles: Decay in the Muon Spectrometer

NEW!

arXiv:1203.1303

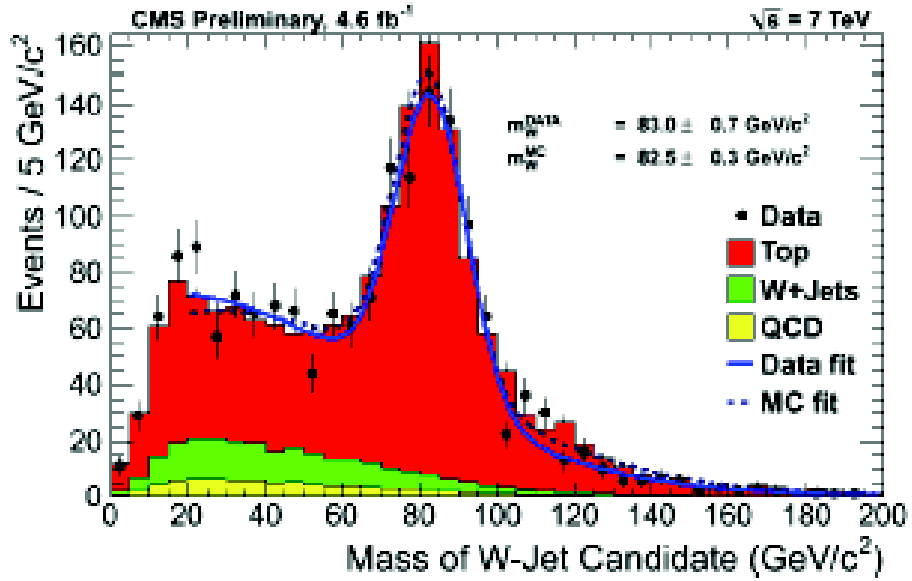
- Hidden-Valley theories predict a hidden sector coupled to the SM only through some heavy communicator → weakly coupled → long-lived particles
- Ex: $h \rightarrow h_v \rightarrow \pi_v \pi_v \rightarrow 4b$'s
- Life-time of π_v is unknown
- Look for 2 pairs of b-jets appearing outside the calorimeter.
- Sort of b-tagging with the Muon Spectrometer!

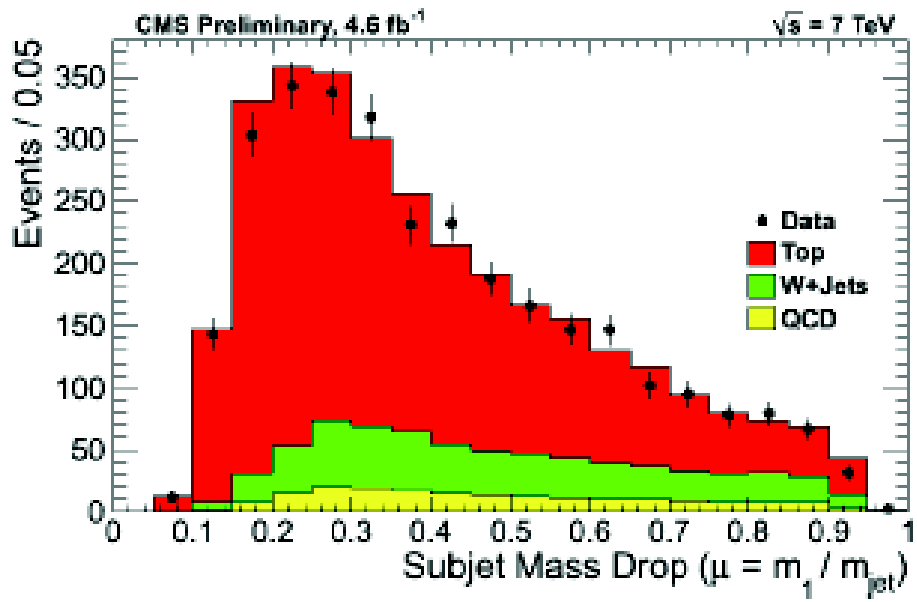




Boosted hadronic Ws – performance

- Look for merged Ws in low mass semileptonic $t\bar{t}$ events
- Use W peak from W-tagged jets to detemine
  - substructure energy correction for MC =1.02 +- 0.01
  - W-tagging efficiency correction for MC = 0.97 +- 0.03
- Madgraph+Pythia Z2 works well





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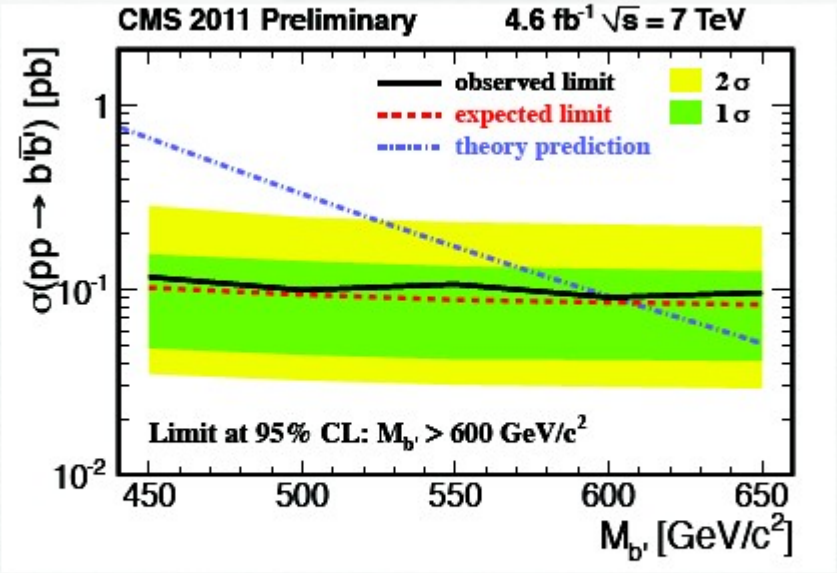
4th generation everywhere in experimental talks

Which (non-susy) new fermions ?

- 4th family — in bad shape
- Top partners in PNGB composite Higgs models
- "exotic" (unusual quantum numbers and less straightforward connection to electroweak symmetry breaking)

e.g. "quirks"

DILEPTON CHANNEL



[CMS L=4.6 fb^{-1}]
PAS-EXO-11-036

$$M_{b'} \gtrsim 600 \text{ GeV}$$

- $(Q, Q') = (2,2)_{2/3}$ $\quad Q = \begin{bmatrix} T \\ B \end{bmatrix}$

(t_L, b_L)

t_R

electric charge +5/3

$$Q' = \begin{bmatrix} T_{5/3} \\ T_{2/3} \end{bmatrix}$$

→ "custodian"

$$M_{Q'} = M_2 = M_Q \cos\varphi_{q_L}$$

$$M_{Q'} \to 0 \quad \text{for} \quad \sin\varphi_{q_L} \to 1$$

- $(1,1)_{2/3} = \tilde{T}$
- $\mathcal{H} = (2,2)_0 = \begin{bmatrix} \phi_0^\dagger & \phi^+ \\ -\phi^- & \phi_0 \end{bmatrix}$

custodians become very light if SM top is largely composite

$$Y_* \, \mathrm{Tr}\{\bar{Q}\mathcal{H}\}\tilde{T} + h.c$$

Géraldine SERVANT, CERN-TH

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- Theory talks:
  - Specific results on relevant topics
  - Reviews by section coordinators

Where we are and where we want to be (plans for the document)

- Wide range of topics covered:
  - Some are well established
    - New fermions
    - New vector bosons
  - Some are in very active development
    - New physics and boosted techniques
    - Long-lived particles
    - Very exotic signatures

Where we are and where we want to be (plans for the document)

- Well established topics
  - Explicit statements about implications of current results for the (near) future can be made
  - Time and page limitation: choices have to be made
    - Ideally choice based on the physics case
    - The clarity of the presentation of the results and interpretation of their implications also a factor
  - Emphasize cases in which specific statements can be made (4th generation, new vectors motivated by $V_L V_L$ unitarization, …)
  - Include discussion of higher energy vs higher lumi (effects of pile-up, etc.)

Where we are and where we want to be (plans for the document)

- Well established topics
  - Discarded topics (for the document to be submitted on July 31) can be included in a longer workshop proceedings type of document
  - All the relevant cases should be covered in the longer document
  - Cross talk with experimentalists even more important in this case (results of these studies could influence the way experimental analyses are performed)

Where we are and where we want to be (plans for the document)

- Topics in active development
  - Very important despite their relatively small degree of “insertion” in the experiments

    • Depending on how you count 2/3 or 2/4 options for SUSY **IMPLY** long lived particles...

    Patrick Meade

  - Large number of possibilities plus difficult signatures
    - Difficult to cover all (model dependence)
    - Difficult to trigger on
    - Goal: list of benchmark exotic scenarios that is manageable but covers enough interesting models

Where we are and where we want to be (plans for the document)

- Topics in active development
  - It is likely that a smaller number of specific points will make their way to the final (short) document
  - Homework: Find specific questions relevant for the document that can be answered by end of July
    - Examples(?):
      - Effect of higher energy/lumi on boosted techniques (pile-up, angular resolution, …)
      - Mapping of displaced vertex/LLP bounds to different models
      - ...
  - Contribution towards long document crucial: this effort could help developing subjects into well established ones

Where we are and where we want to be (plans for the document)

A possible outline for the "flavor chapter" of WG3

- Motivation
  (*role of flavor in constraining NP*)
- Status of the art
  (*discussion of present "anomalies"*)
- General classification of NP models
  (*as far as low-energy flavor physics is concerned*)
- Minimal list of key observables
- Future exp. prospects for the key observables

Where we are and where we want to be (plans for the document)

- Open questions
  - Flavor: a separate document?
  - Top new physics (non-necessarily boosted)
  - Top flavor violation
  - Lepto-quarks
  - New scalars, higher spins?
  - Strong gravity signatures: black holes, Regge resonances, multi-final state signatures, …
  - ...

Where we are and where we want to be (plans for the document)

- Time is short!
  - Document should be essentially finalized by the July 13-17 meeting
  - Final (minimal) details up to July 31
  - Ideally new results in the document
  - Known but relevant results should also go in there
  - It is crucial to focus on what has to go in the (short) document and the work that has to be done (this is urgent) but to also keep in mind the long document.