Constraining Composite Higgs models

Giuliano Panico

CERN Theory Group Retreat – 6-8 Nov 2013

BSM phenomenology

My research is focused on the **phenomenology of BSM theories**

Main goal of this research (and of the LHC):

Unveil the **nature of the EWSB mechanism**

General strategy:

Build **theoretical framework** to interpret the data

- look for **motivated** scenarios
- develop and test hypothetical **models**

Probing composite Higgs scenarios

In my recent works I considered scenarios with new strong dynamics giving rise to a **Composite Higgs**

Derive constraints with a **model-independent approach**:

- bounds from EW precision measurements
- bounds from LHC direct searches

Indirect bounds from EW data

[Grojean, Matsedonskyi, G. P. 2013]

Develop a general model-independent parametrization of the dynamics of the lightest fermionic resonances (useful for LHC phenomenology)

see also [De Simone, Matsedonskyi, Rattazzi, Wulzer 2012]

Identify the EW observables that are determined by the IR physics (less sensitive to UV completion):

- best observable: T parameter (finite and UV insensitive)
- S can be dominated by enhanced IR contributions
- $Zb\bar{b}$ can receive large UV corrections

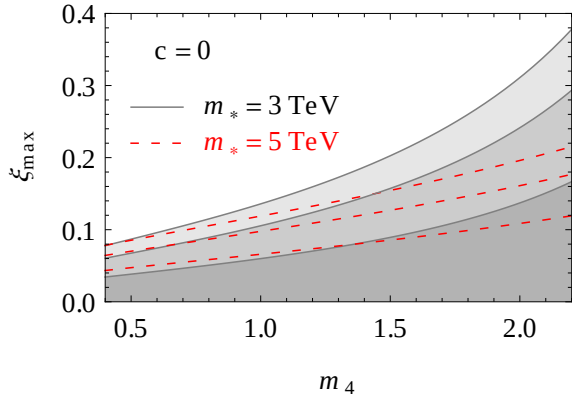
Indirect bounds from EW data

[Grojean, Matsedonskyi, G. P. 2013]

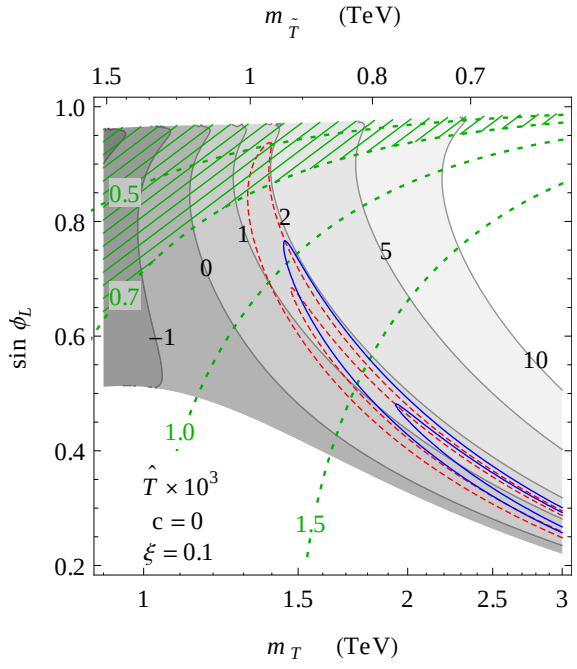
The S parameter can receive sizable contributions from light resonances

- strong bounds on compositeness

$$\xi \equiv (v/f)^2 \lesssim 0.1$$



Constraints from EW data in many models are still **stronger** than direct exclusion



Light quark compositeness [Delaunay, Flacke, Gonzales-Fraile, Lee, G.P. and Perez, in progress]

Non-trivial flavor structures can lead to a sizable amount of compositeness for the light generation quarks

see for example [Fitzpatrick, Perez, Randall 2007; Csaki, Falkowski, Weiler 2008; Csaki, Perez, Surujon, Weiler 2009; Redi, Weiler 2011 ...];

- Compositeness for R-handed quarks: u_R, c_R
- Light generations mixed with light fermionic resonances

Light quark compositeness: LHC bounds

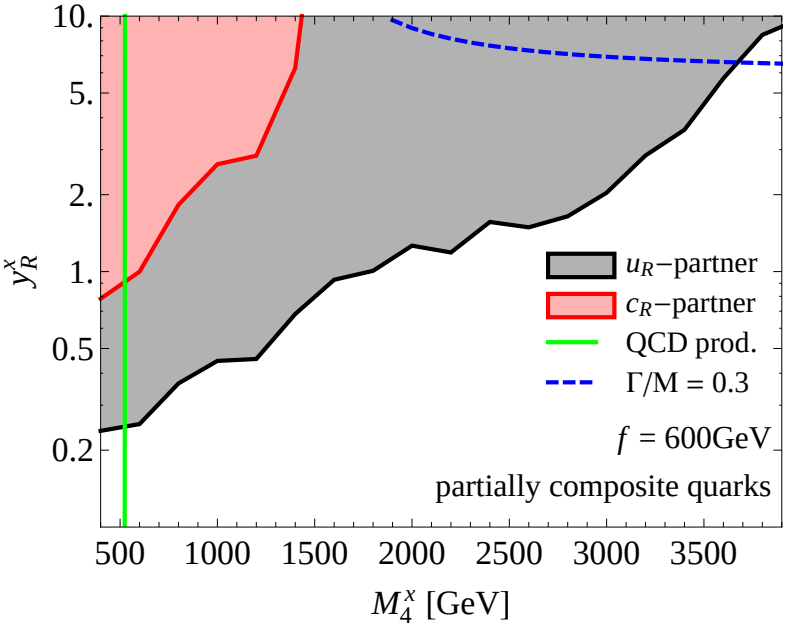
For partners in non-trivial representations: $X \to W\,j$ or $X \to Z\,j$

In flavor universal models:

- same compositeness for u_R, c_R and t_R ($y_R \gtrsim 1$)
- very **stringent bounds**: $M_{part} \gtrsim 1.7$ TeV

Relaxing the universality structure:

- only **mild direct bounds** on c partners: $M_c \gtrsim 500$ GeV

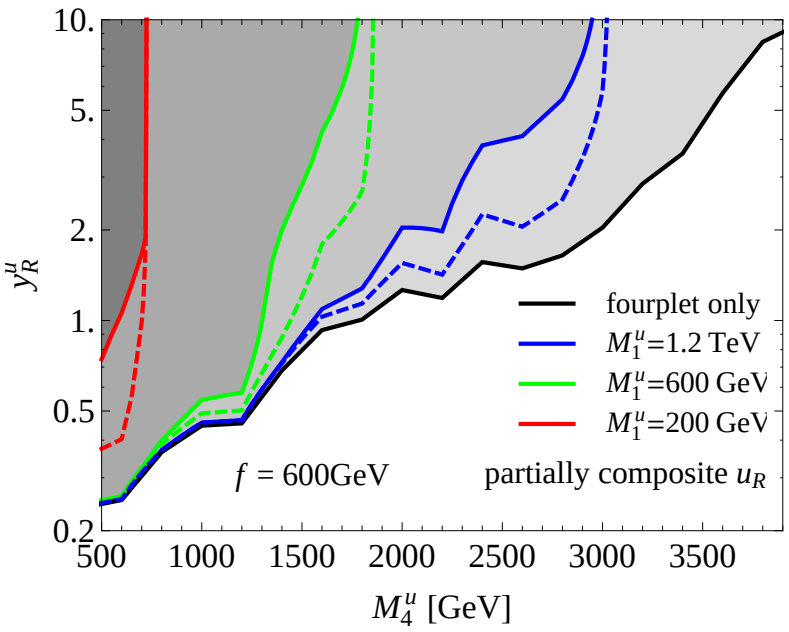


Light quark compositeness: LHC bounds

Singlet partners have 'difficult' signatures: $X \to h\,j$
(or $X \to jj\,, jjj$ see [Redi, Sanz, De Vries, Weiler])

- so far no direct LHC constraint

Mixing and chain decays through a singlet can significantly reduce the bounds on other partners



Recent publications and current projects

Recent **publications**:

- Panico, Redi, Tesi and Wulzer, "On the Tuning and the Mass of the Composite Higgs," JHEP **1303** (2013) 051 [arXiv:1210.7114 [hep-ph]].
- Grojean, Matsedonskyi and Panico, "Light top partners and precision physics," JHEP **1310** (2013) 160 [arXiv:1306.4655 [hep-ph]].
- Delaunay, Flacke, Gonzales-Fraile, Lee, Panico and Perez, "Bounds on non-degenerate fermionic resonances in composite Higgs models", arXiv:131x.xxxx [hep-ph].

Current **projects**:

- Bounds on top partners from LHC searches

  [with Matsedonskyi and Wulzer]
- Bounds on double Higgs production in BSM scenarios

  [with Azatov, Contino, Son et al.]