

# Probes of Higgsless Models

Verónica Sanz (York)



# Early Probes of Higgsless Models

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The LHC

Origin of mass

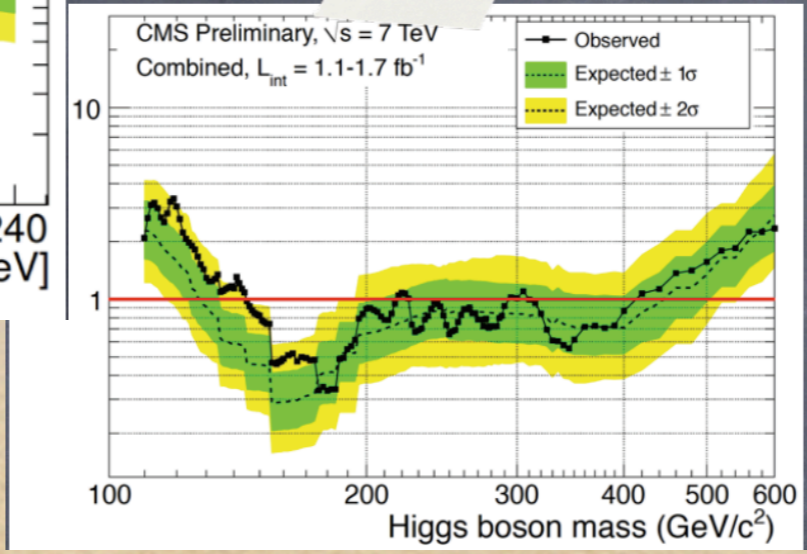
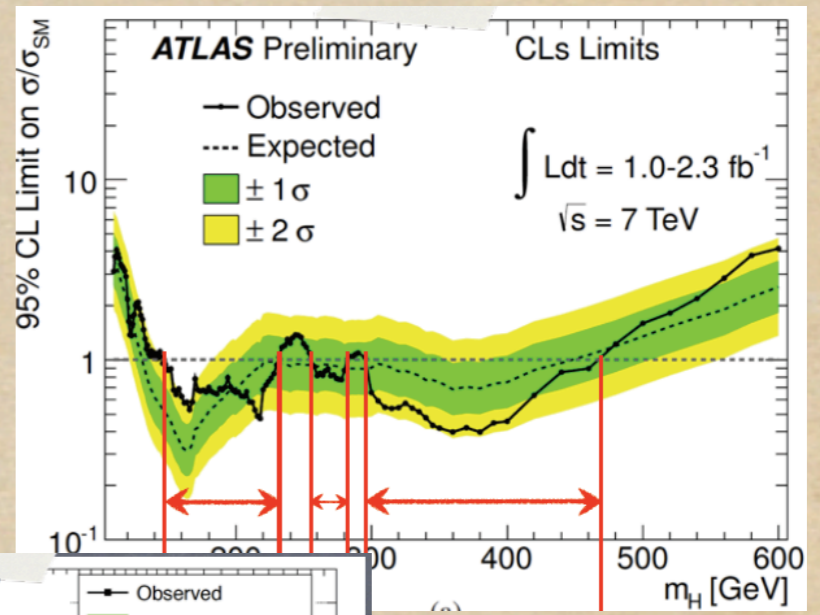
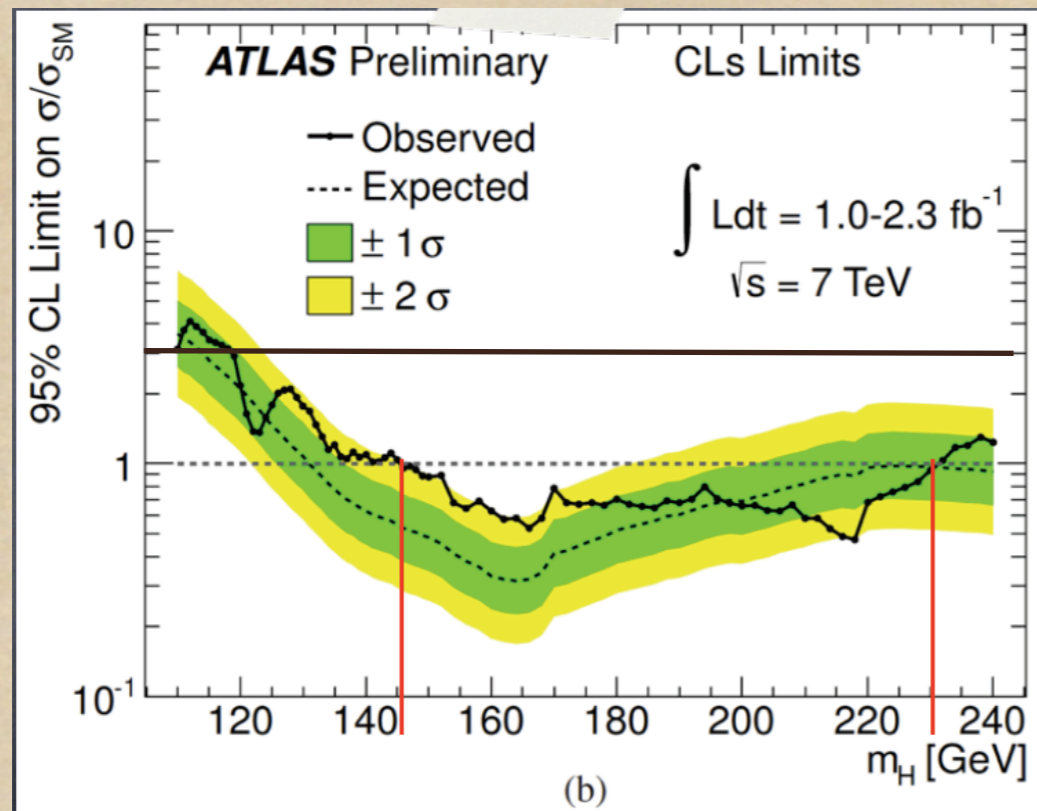
EWSB



# The LHC

# Origin of mass

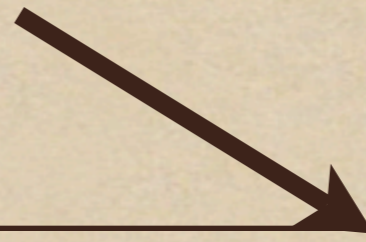
# EWSB



10 ifb, factor 3



Moriond 2012  
no SM Higgs

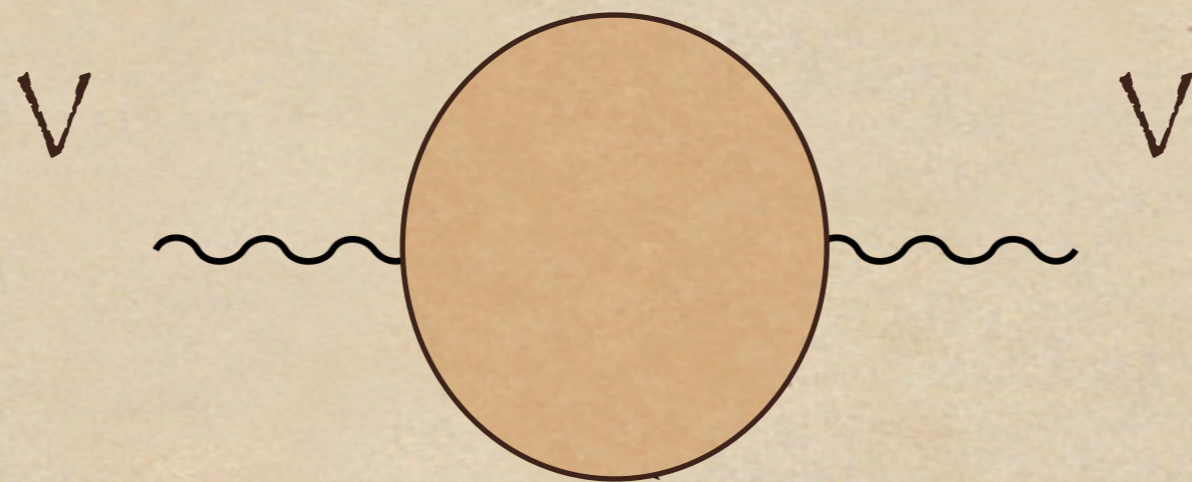


More complex  
(perturbative)  
Higgs sector

No Higgs mechanism  
EWSB new  
strong interactions  
or extra-dimensions



Why we love the Higgs  
precision data (indirect)  
light, elementary Higgs



Higgsless and precision data?  
calculable framework



# My Higgsless

XDIMS

(warped, RS, deconstructed)

EFT w/ limited range of validity, enough for precision data

1. EWSB as BCs
2. Unitarization: no H, but  $s=1$  resonances
3. Validity: narrow resonances
4. Precision data: bulk matter



In a nutshell

No Higgs

Unitarity:

Massive, narrow  $s=1$  resonances w/  
specific couplings to the W,Z

Precision tests:

Fermionic resonances w/ couplings to SM



No Higgs

VBF, TGCs  
(2014+)

Unitarity:

Massive, narrow  $s=1$  resonances w/  
specific couplings to the W,Z

Precision tests:

Fermionic resonances w/ couplings to SM

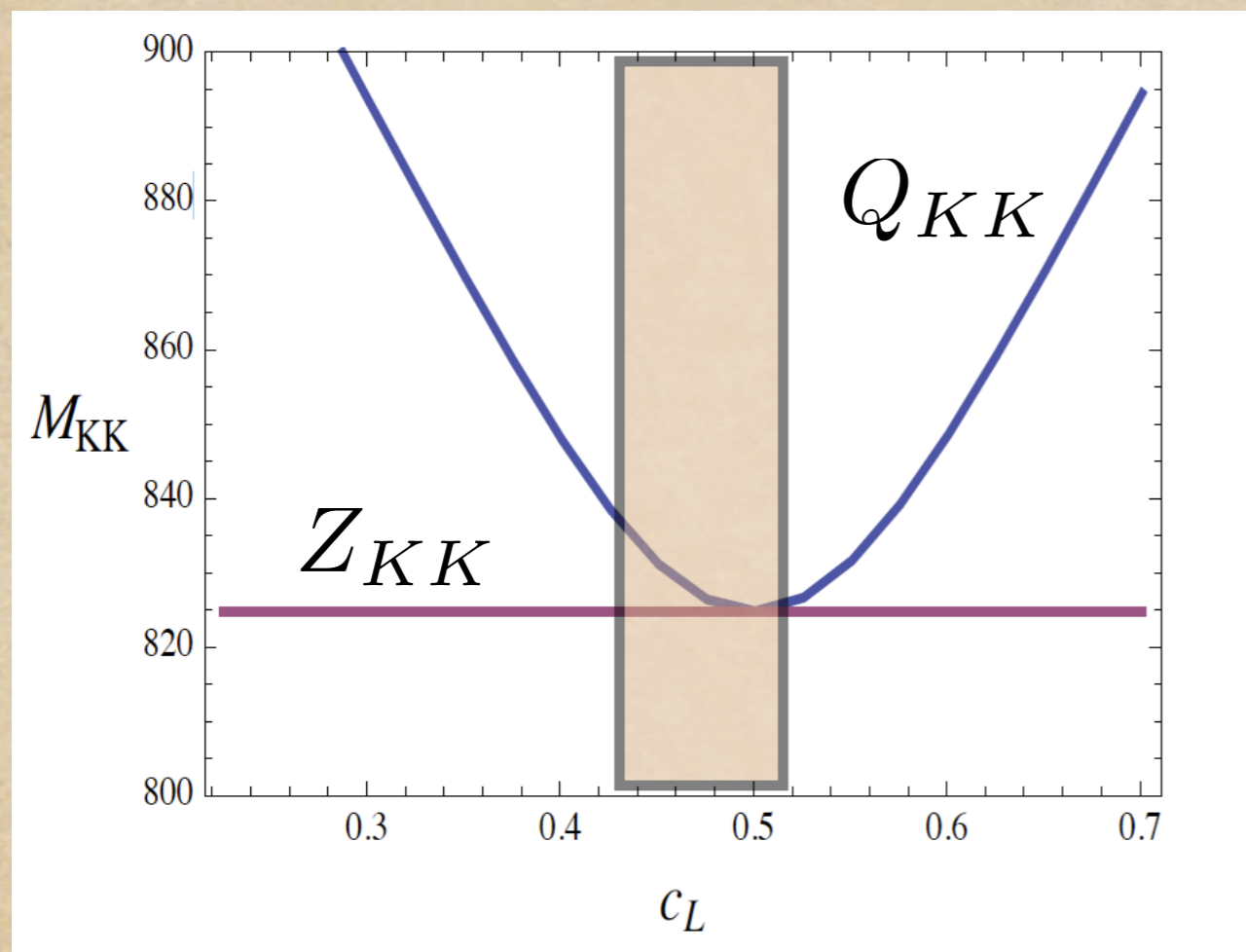


Early Probes of Higgsless  
and precision tests



# Precision tests in Higgsless: cancellation close-by resonances

**Cured Higgsless.** Cacciapaglia et al. *Phys Rev D* '05  
**Holographic TC.** Hirn and VS. *Phys Rev Lett* '06



Cured Higgsless  
cancellation  
 $s=1$  and  $s=1/2$

Martin and VS. *JHEP*'10



# $s=1$ sector

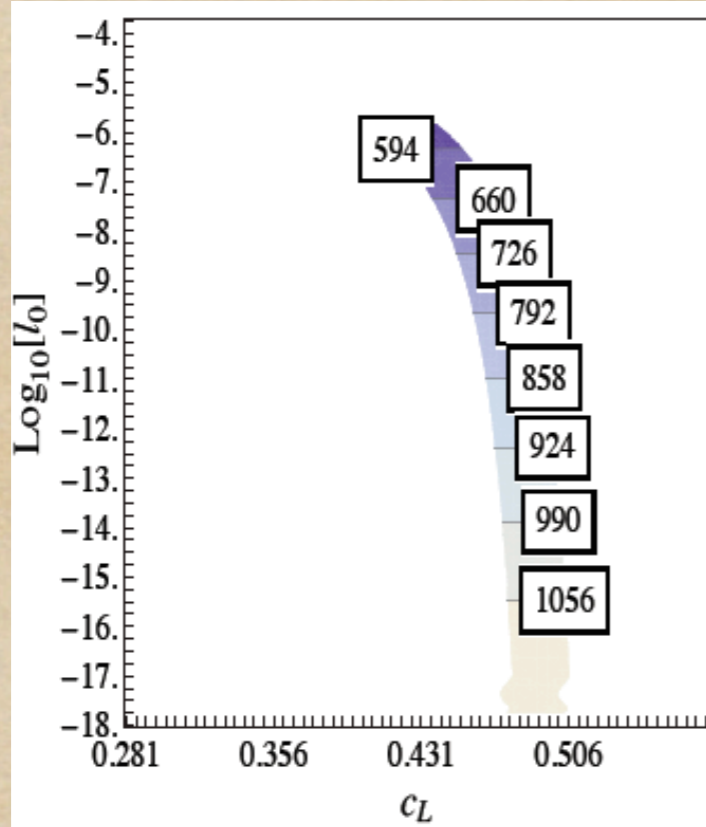


Figure 3: Masses with  $|S| < 0.5$  and  $|T| < 0.3$

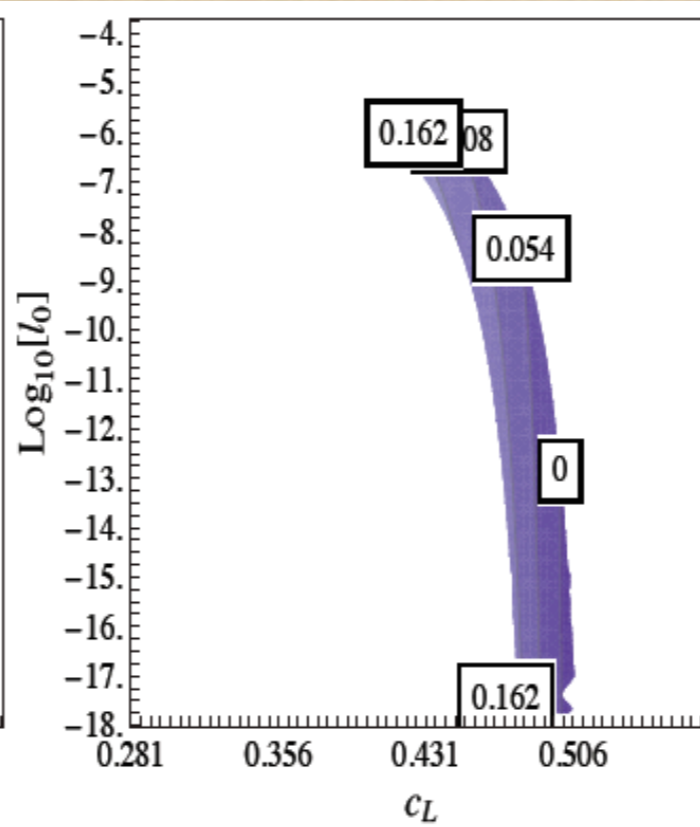


Figure 4: Couplings with  $|S| < 0.5$  and  $|T| < 0.3$

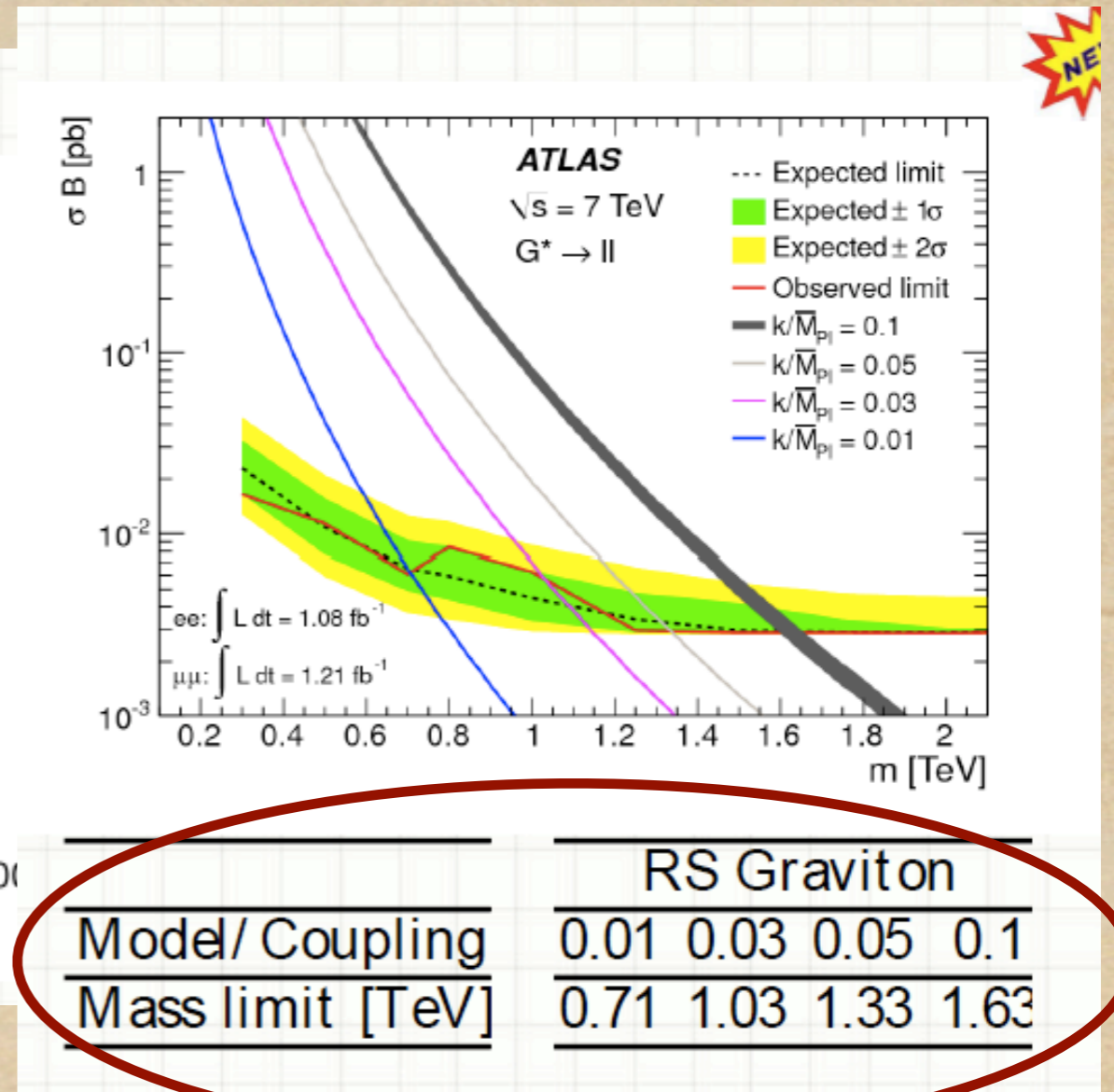
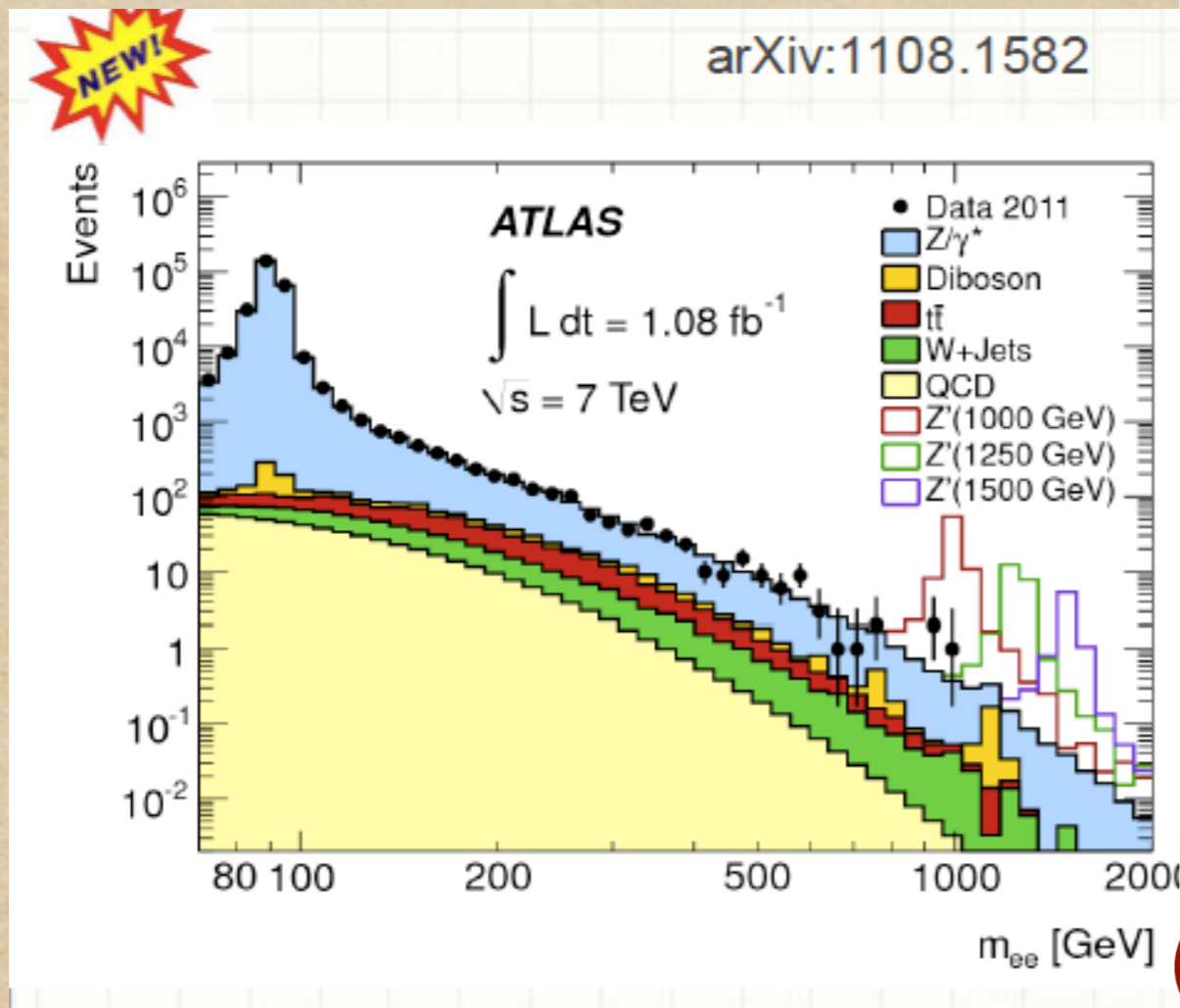
coupling  $Z'$  to  
SM fermions



$s=1$  sector

CMS and ATLAS

chopping down Higgsless param space





$s=1$  sector

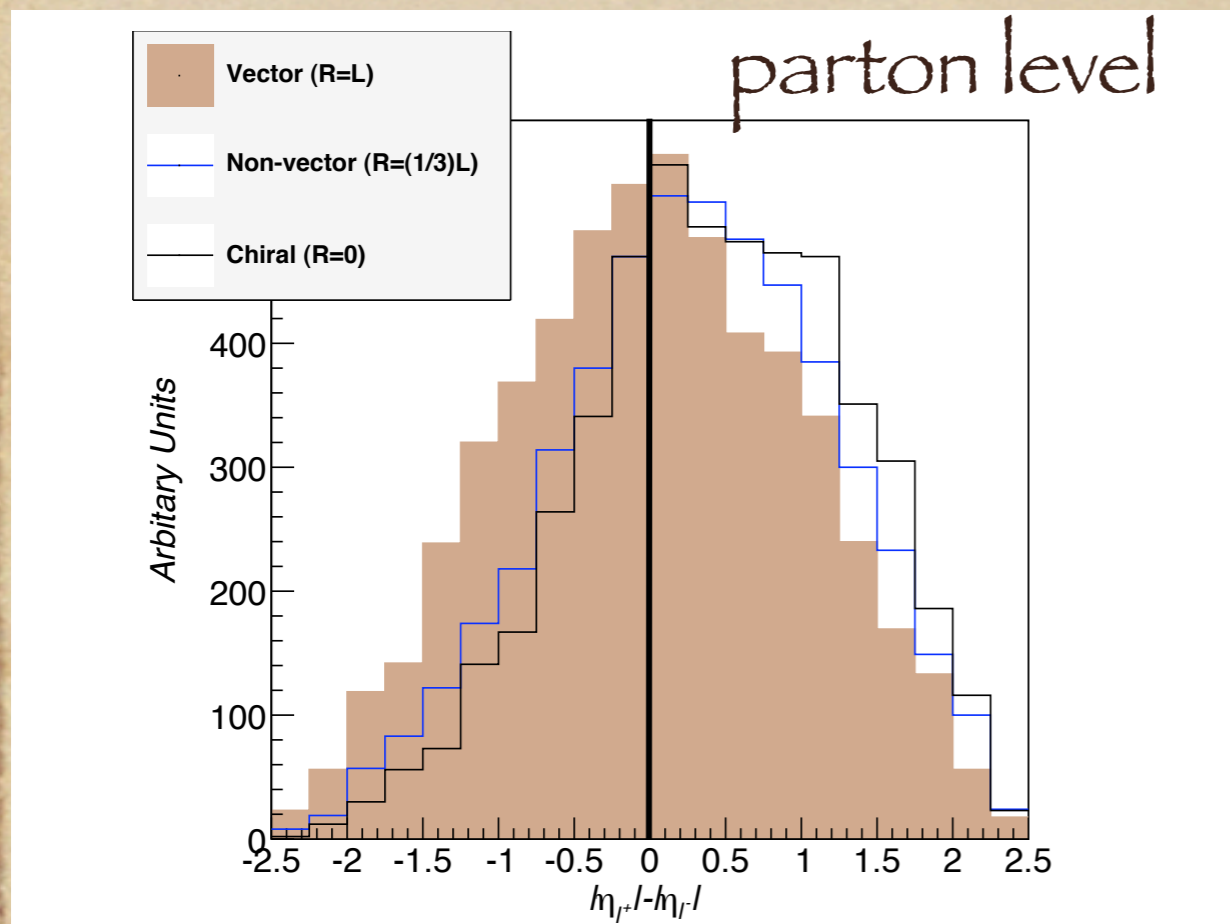
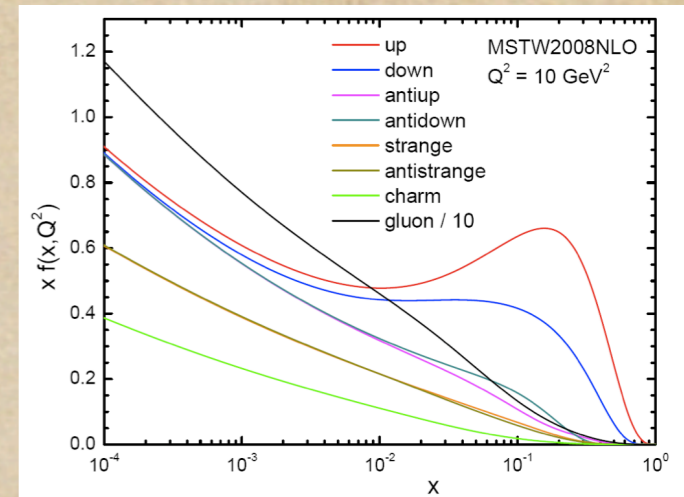
But if we see a  $Z'$  in dileptons  
 $Z'$  participates in EWSB?

Dilepton asymmetry



# $s=1$ sector

Heavy resonance through  $q \bar{q}$  system boosted towards incoming  $q$



chiral content of  $Z'$   
 mixing w/  $Z$   
 predicted in the model

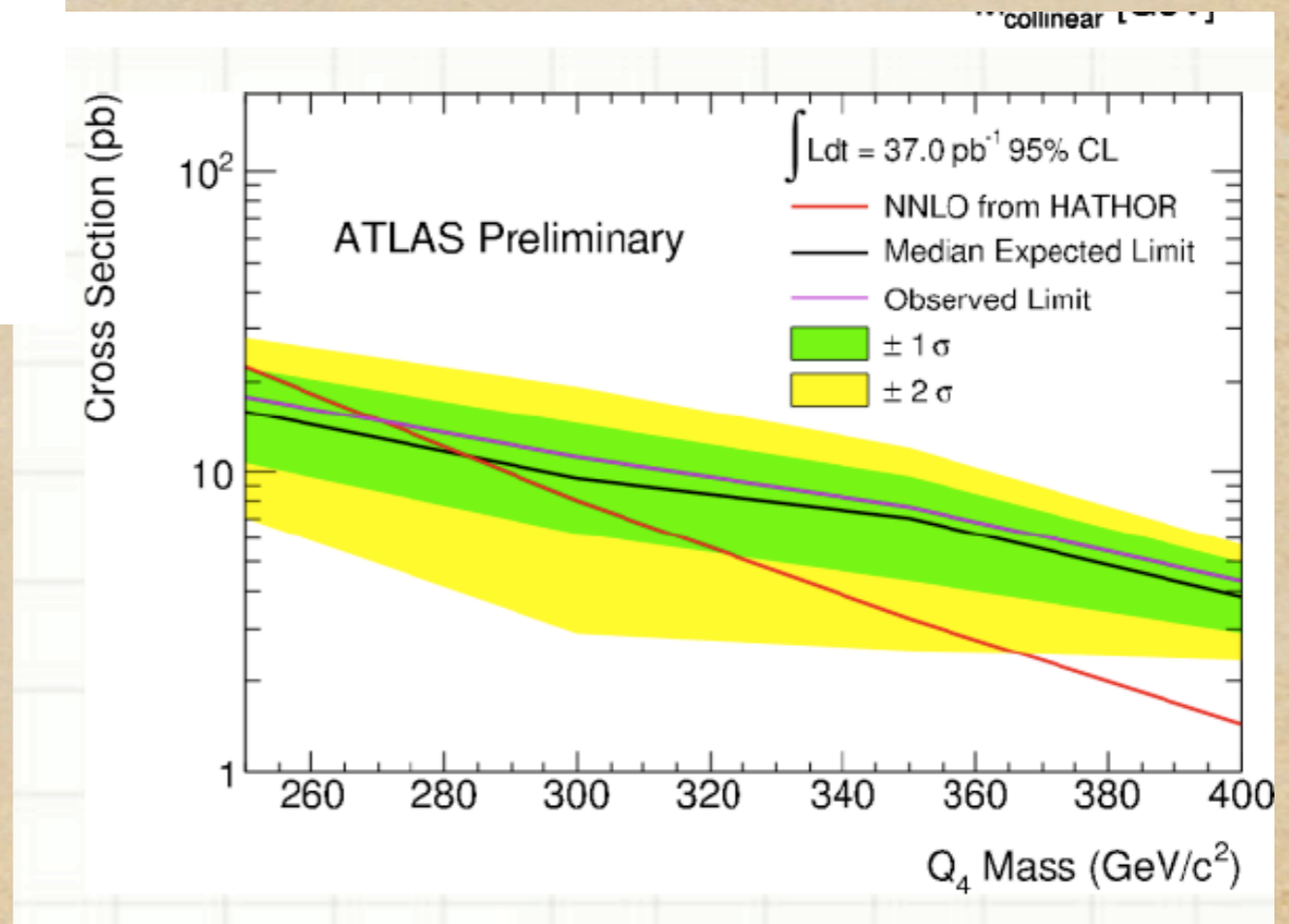
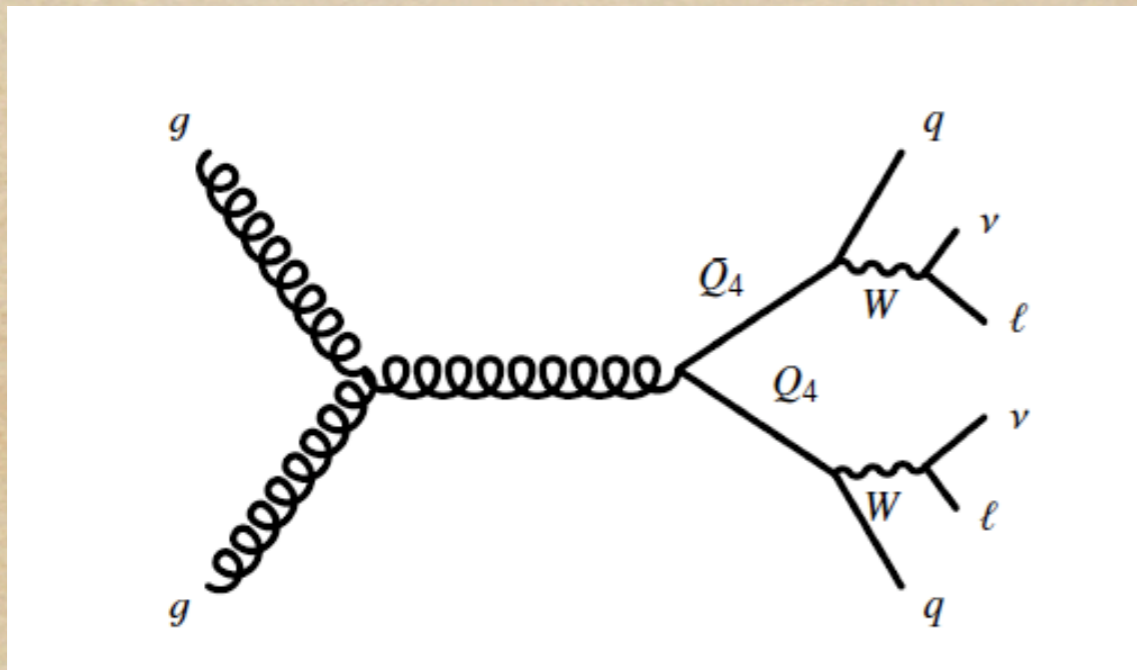
$$|\eta_{e^+}| - |\eta_{e^-}|$$

Banerjee, Martin and VS. *In preparation.*



$s=1/2$  sector

# "Old" ATLAS search

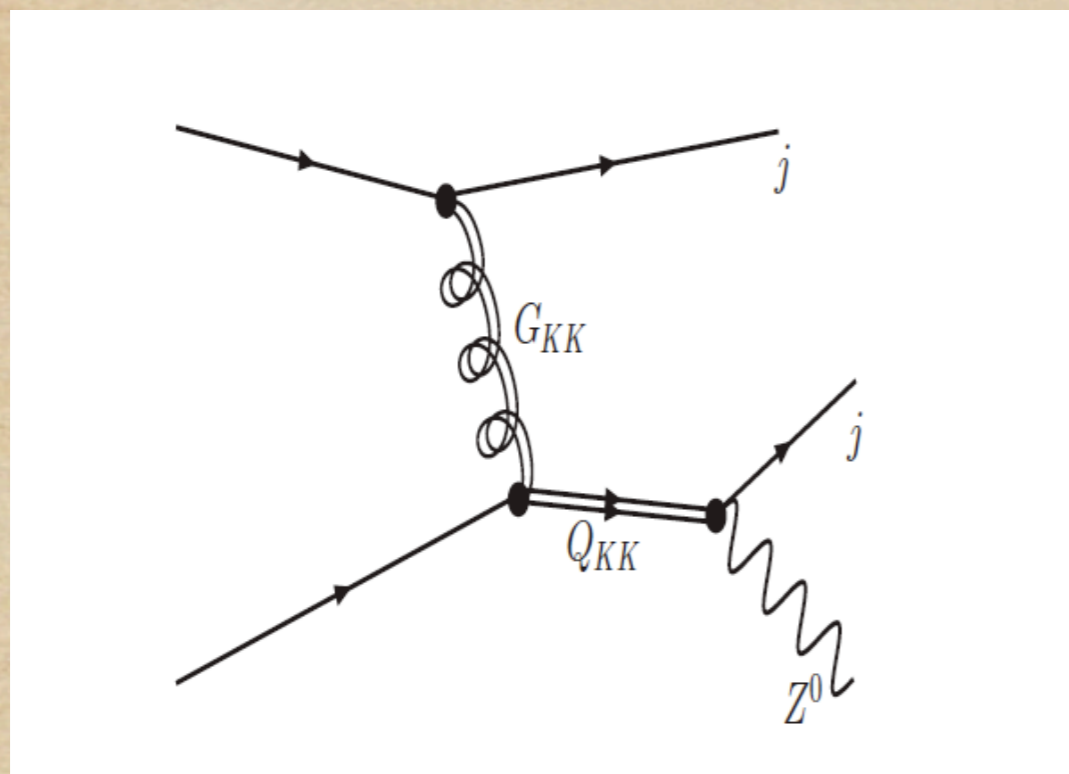




$s=1/2$  sector

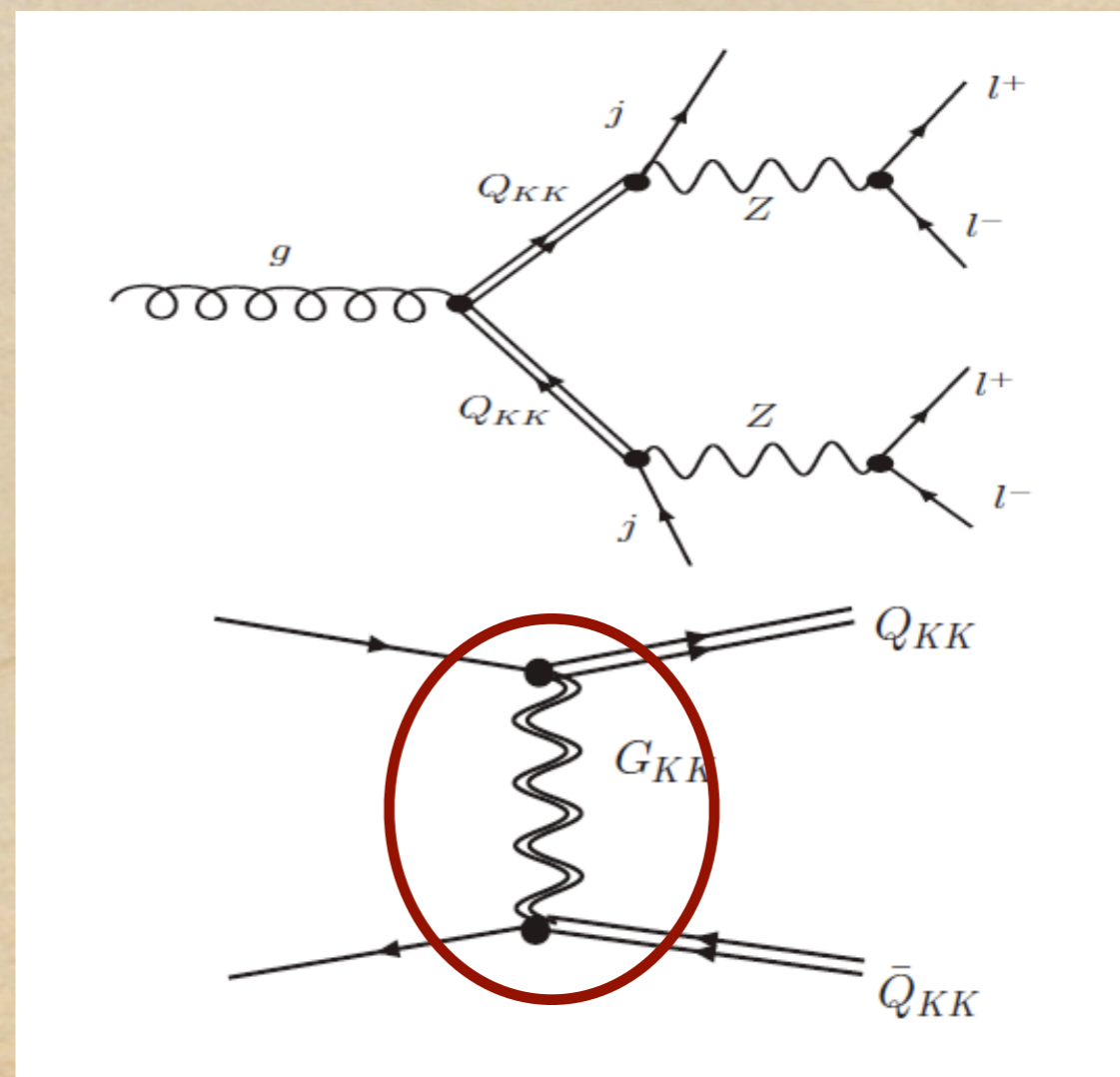
BUT best channels for KK-quarks in Higgsless  
are NOT what ATLAS looked for

Single production



Martin and VS. JHEP'10

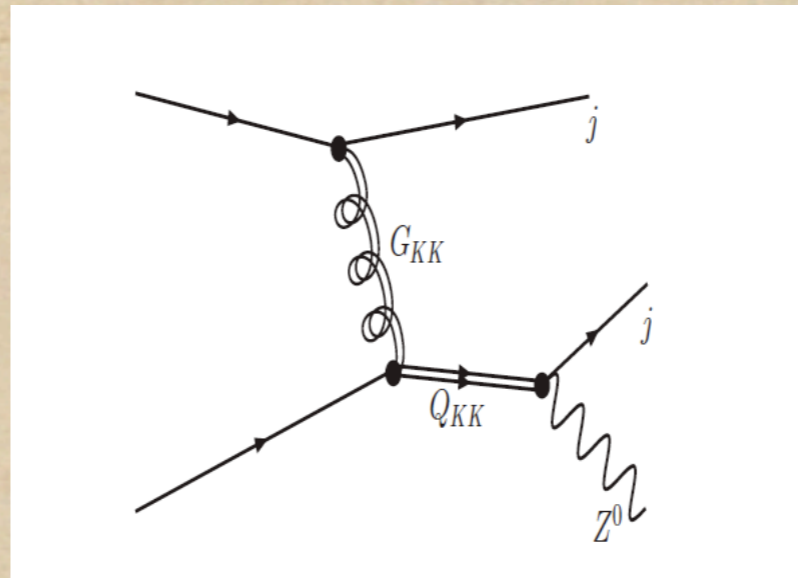
Pair production





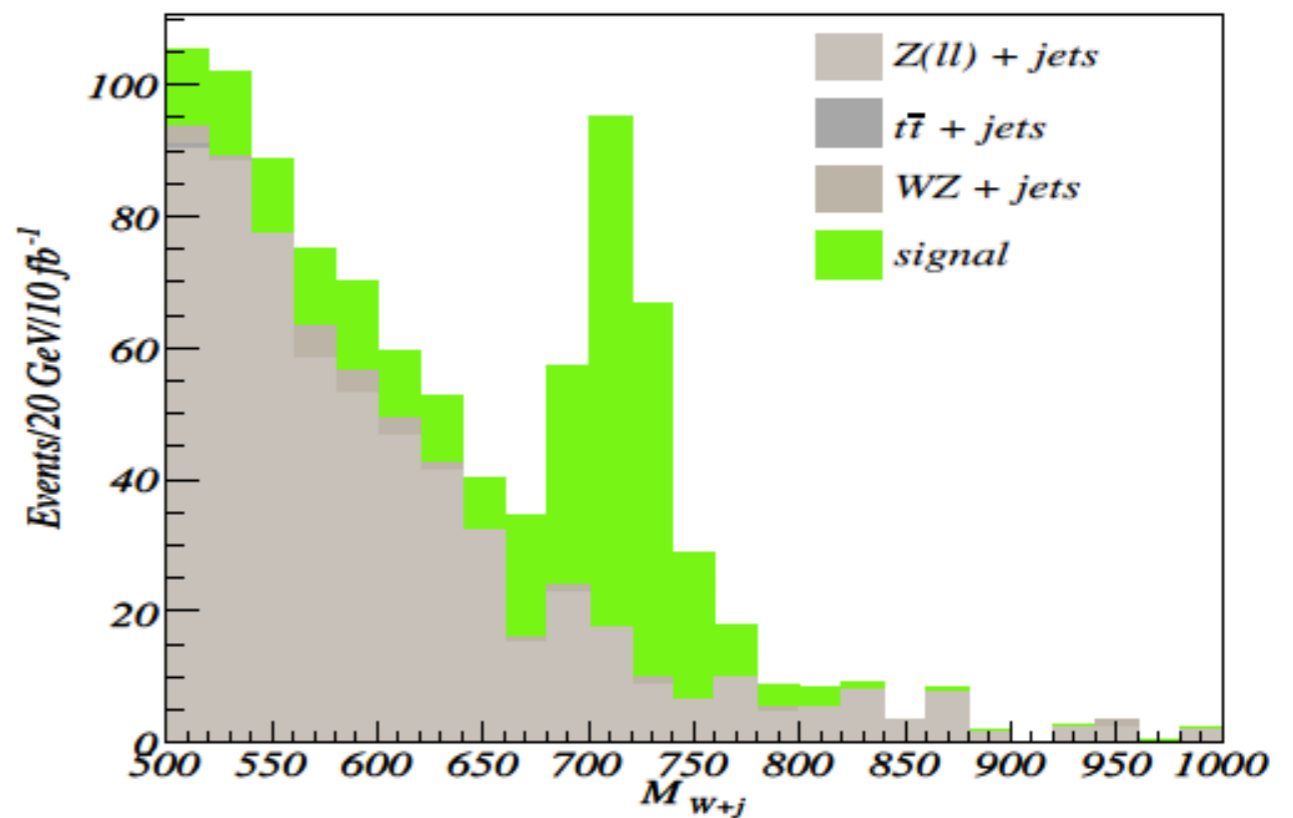
$s=1/2$  sector

For example:  
2 leptons + 2 jets



MG and ALPGEN,  
Pythia, PGS simulation  
at 10 TeV

Martin and VS. JHEP'10





Mass measurements  $s=1$  and  $s=1/2$ :

precision tests

Lepton asymmetries: info on the

couplings,  $Z'$  EWSB



By the way...

Not in RS models, but in more general warped/  
composite models

$$q q' \rightarrow W_{KK} \rightarrow W \gamma$$

lepton+photon+MET

Hirn, Martin and VS. Phys Rev D'08

Lane, Martin. Phys Rev D'09



## Wrapping up

Early probes of Higgsless models

~~size of the  $W'WZ$  coupling~~

mass relations

asymmetries

I propose

1. Dilepton FB asymmetry
2. Searches for light-quark partners in multileptons+high- $p_T$  jets
3. Searches  $W$ photon resonances