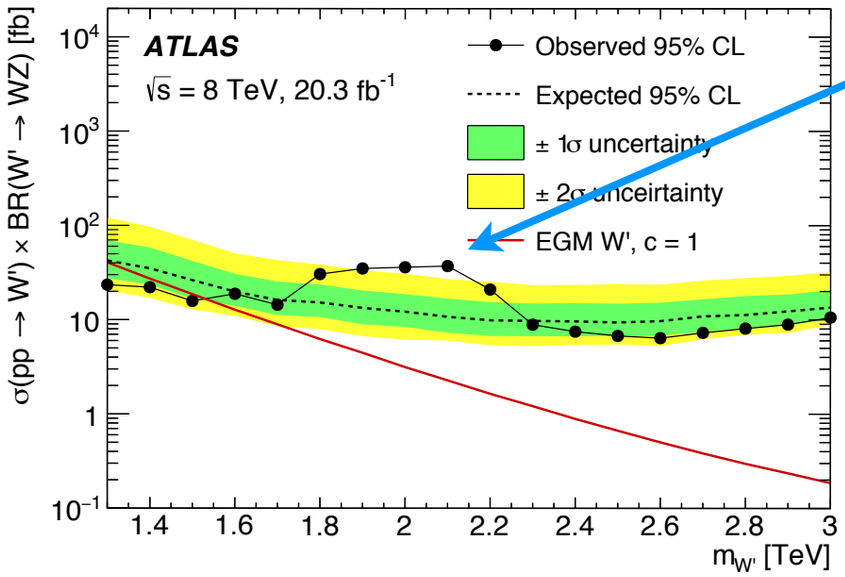
# The mistery of the five little bumps

A tale by J. A. Aguilar Saavedra

Red LHC workshop, IFT, May 8th 2017

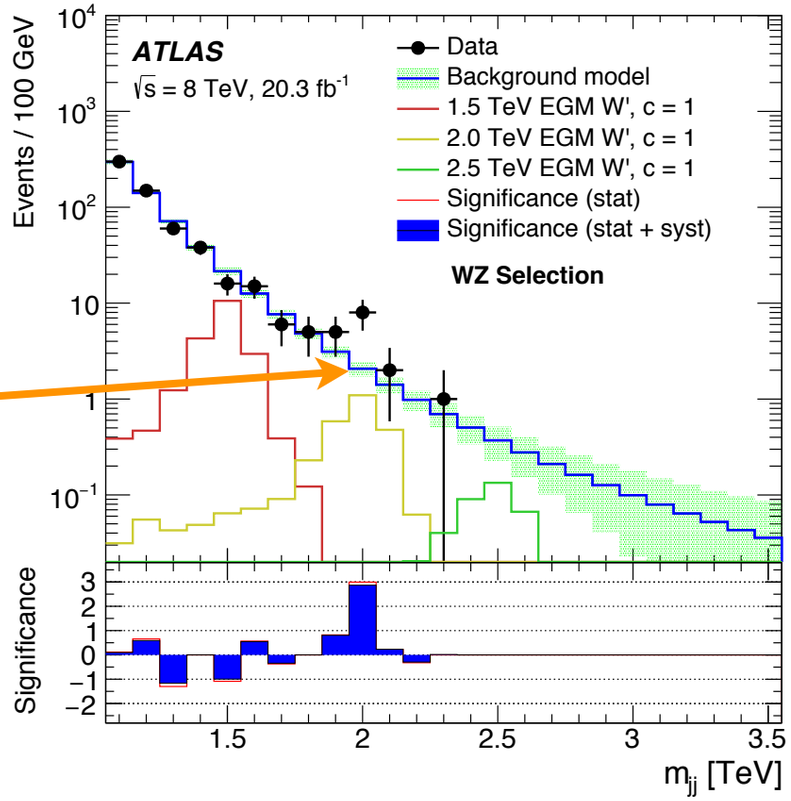
# Run 1: excitement in $VV \to JJ$

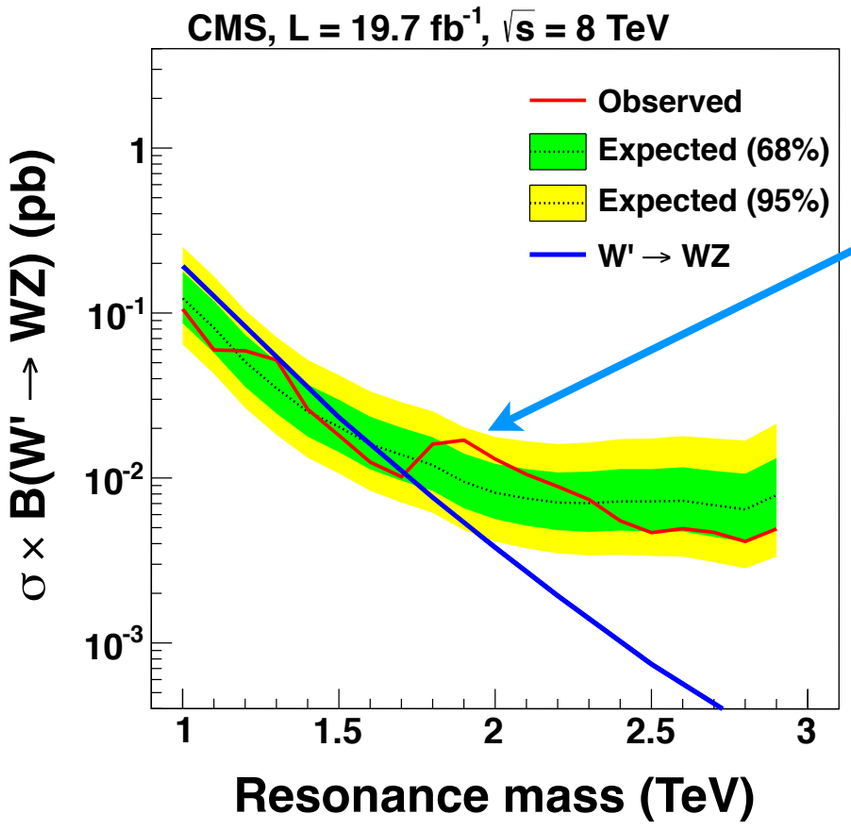
ATLAS arXiv:1506.00962
CMS arXiv:1405.1994




3.4σ

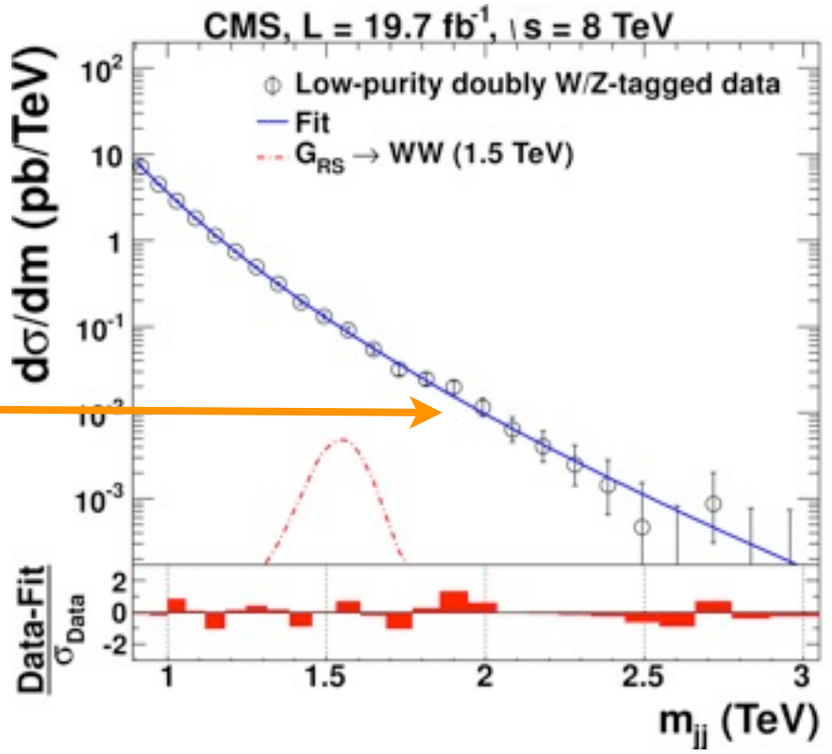
2 exp 8 obs
/100 GeV




~1.5σ

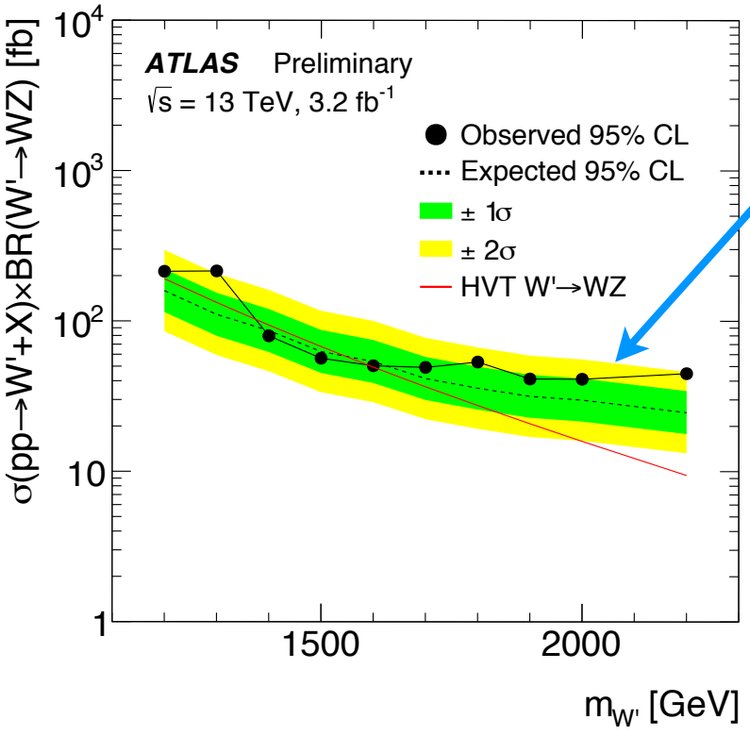
30 exp 39 obs
/100 GeV



# ATLAS Run 2 / 3.2 fb$^{-1}$: the phantom bump

ATLAS-CONF-2015-073
December 2015

## Brand new event selection



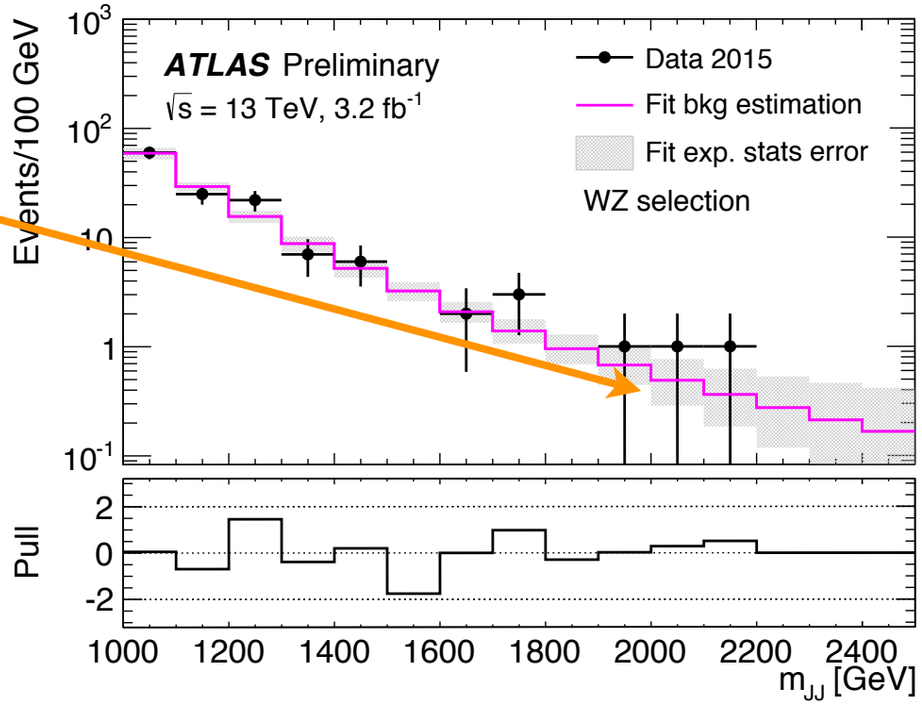

~1σ

0.7 exp 1 obs
/100 GeV

4-7x harsher
cuts than Run 1

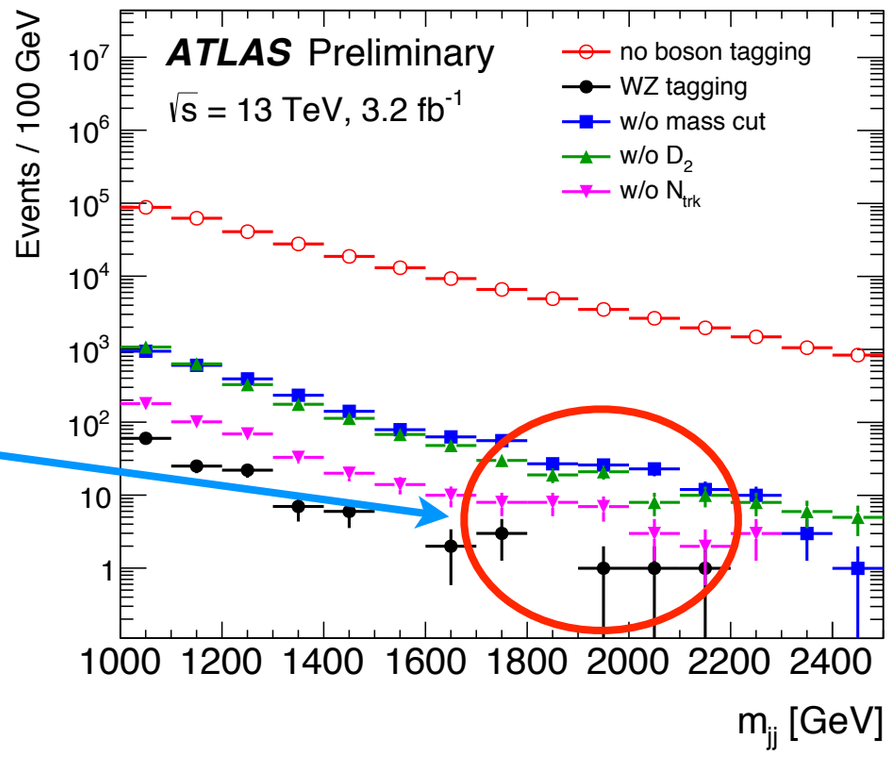
PDF & lumi scale of
<u>expected</u> bkg (QCD)

$$(8-15)\times\frac{3.2}{20.3}$$




… hope survives
with looser selection (!)

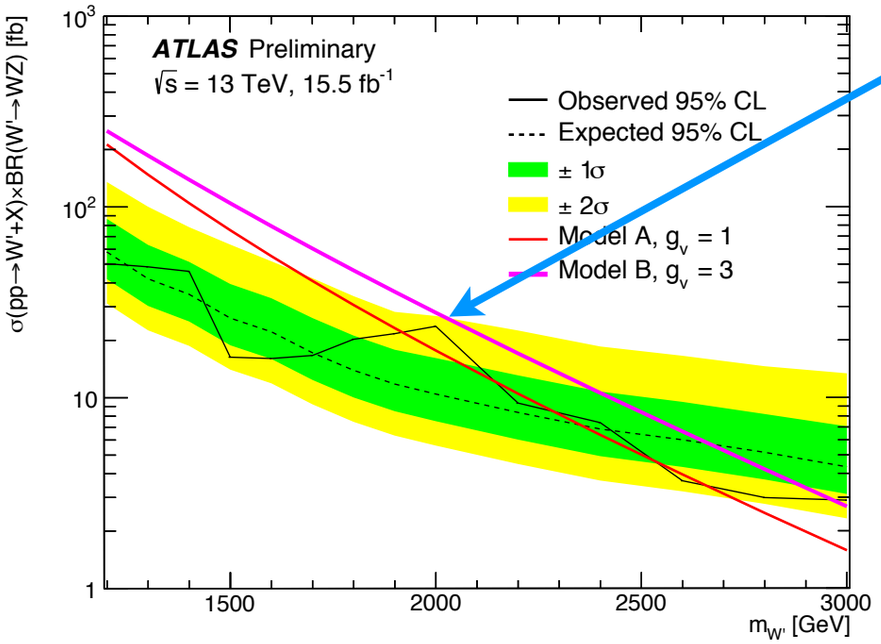
2.4σ



# ATLAS Run 2 / 15.5 fb$^{-1}$: the bump strikes back

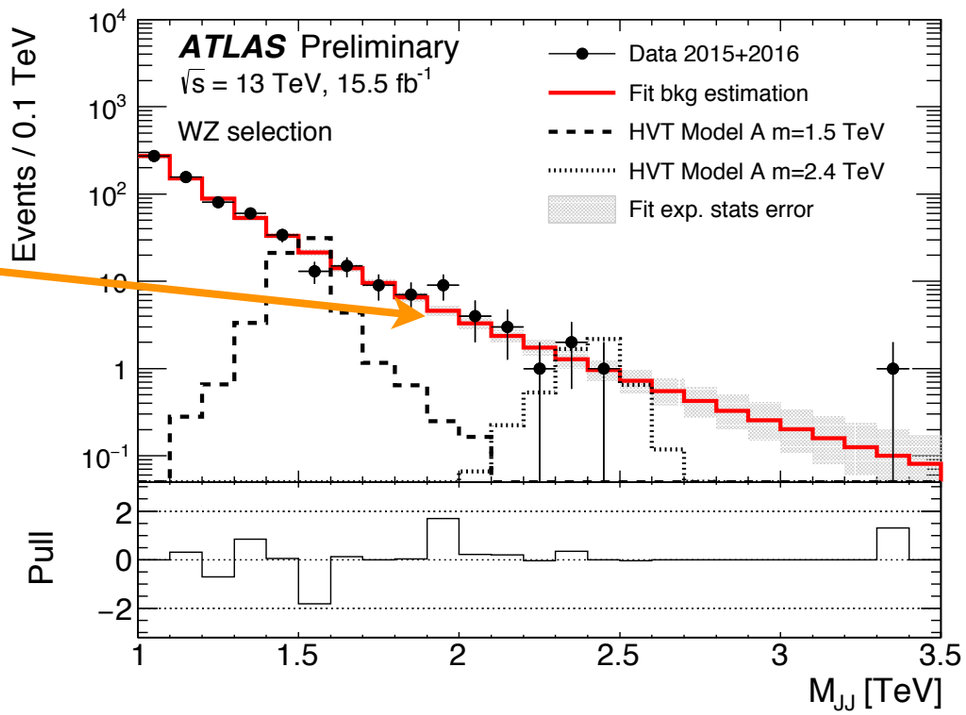
ATLAS-CONF-2016-055
August 2016

## More luminosity



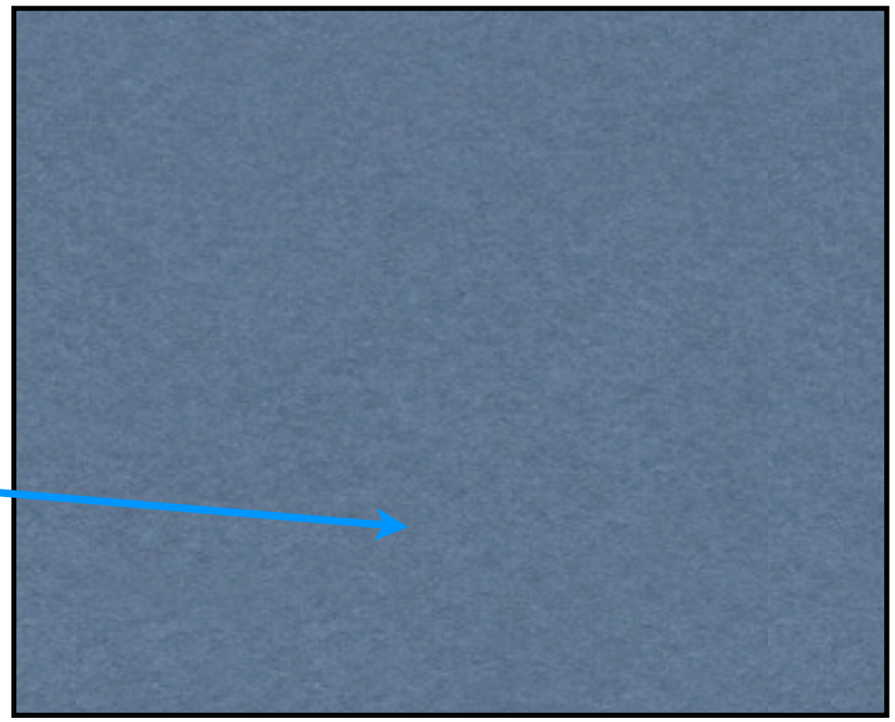

1.9σ

4.5 exp 9 obs
/100 GeV




## No results released with looser selection

?

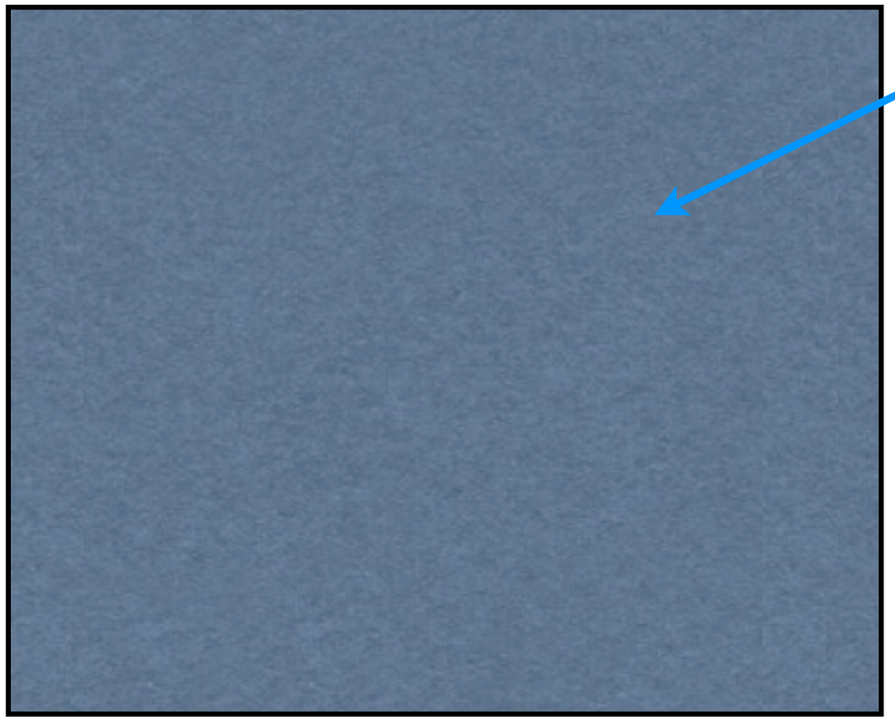


# CMS Run 2 / 2.6 fb$^{-1}$: the phantom bump (2)

CMS-PAS-EXO-15-002
January 2016

## New: *W* vs *Z* `discrimination´

?



$\tau_{21}$ < 0.45 (HP), 0.75 (LP)

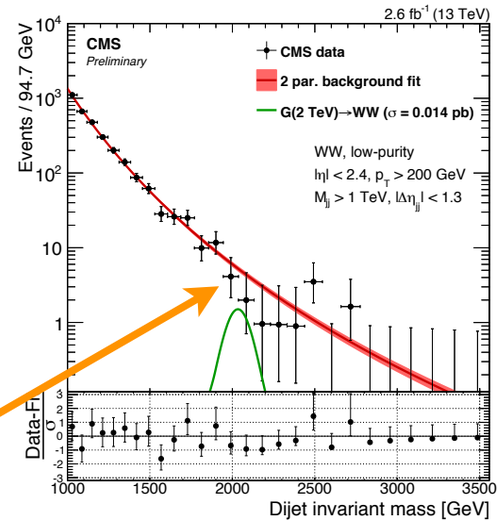
Limits not calculated
for *JJ* channel alone;
combined limits useless

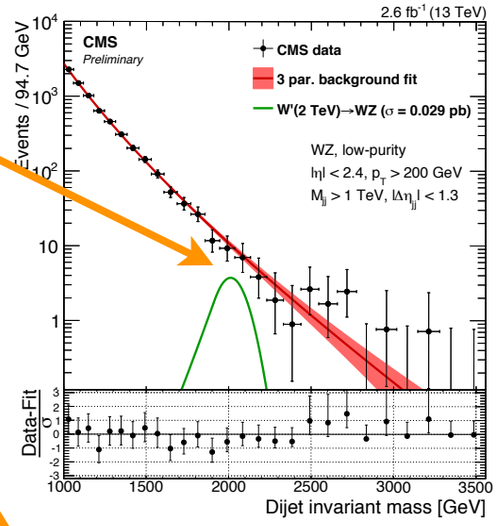
Overall
~33 exp ~26 obs
/100 GeV

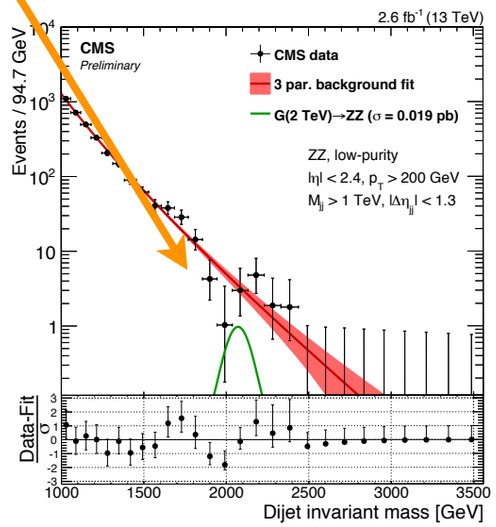
1-2x harsher cuts
than Run I
(LP selection)

PDF & lumi scale of
<u>expected</u> bkg (QCD)

$$(8-15)\times\frac{2.6}{19.7}$$

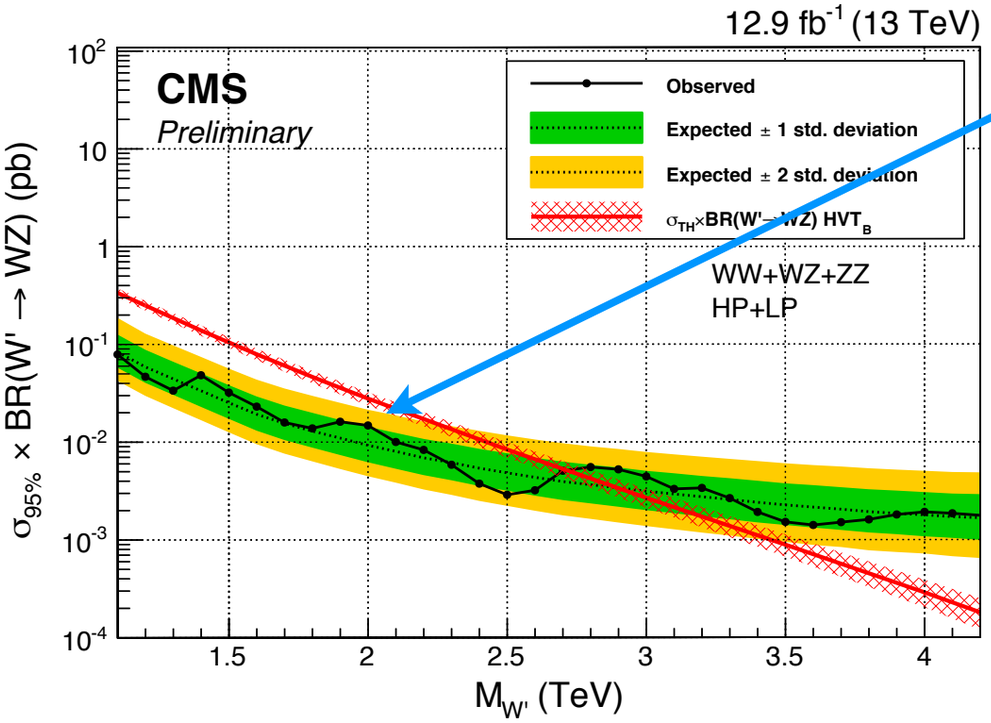


# CMS Run 2 / 12.9 fb$^{-1}$: the awakening of the bump

CMS-PAS-B2G-16-021
December 2016

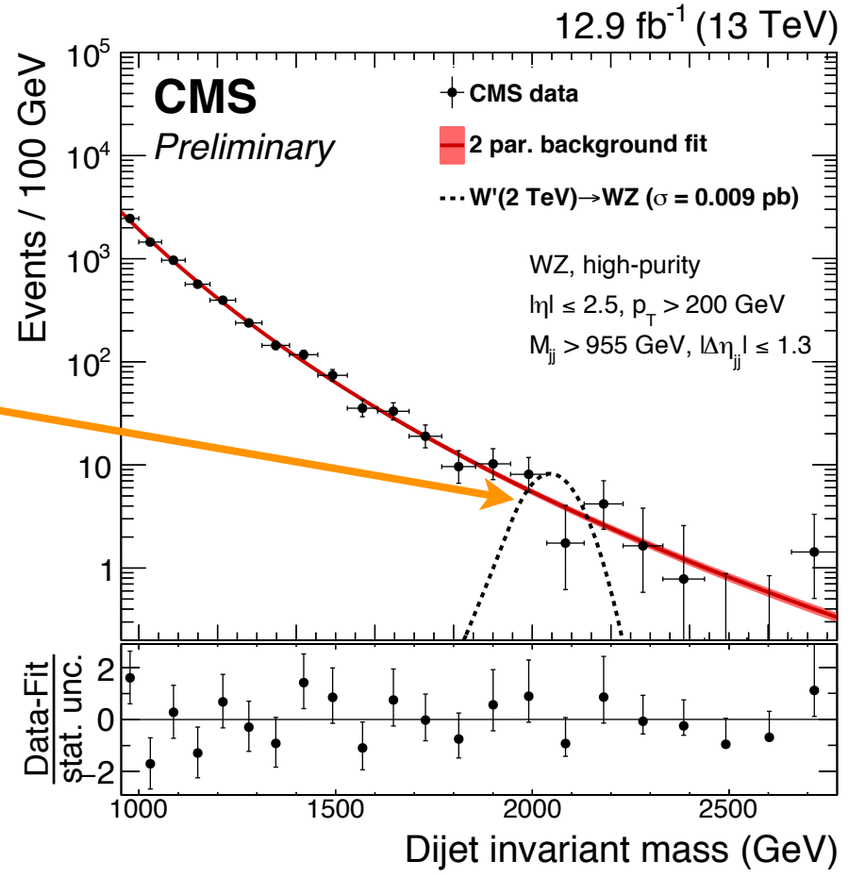



$\tau_{21}$ < 0.4 (HP), 0.75 (LP)

~1σ

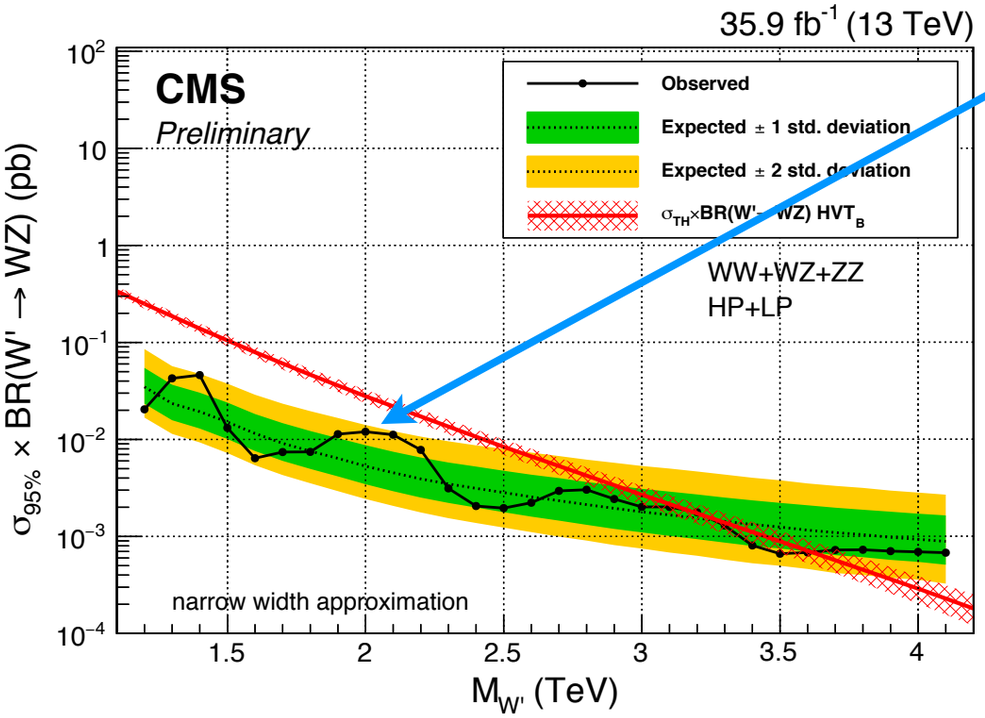
5.7 exp 8 obs /100 GeV

~4x harsher cuts than 2.6 fb$^{-1}$ (HP selection)



# CMS Run 2 / 35.9 fb$^{-1}$: return of the bump

CMS-PAS-B2G-17-001
March 2017

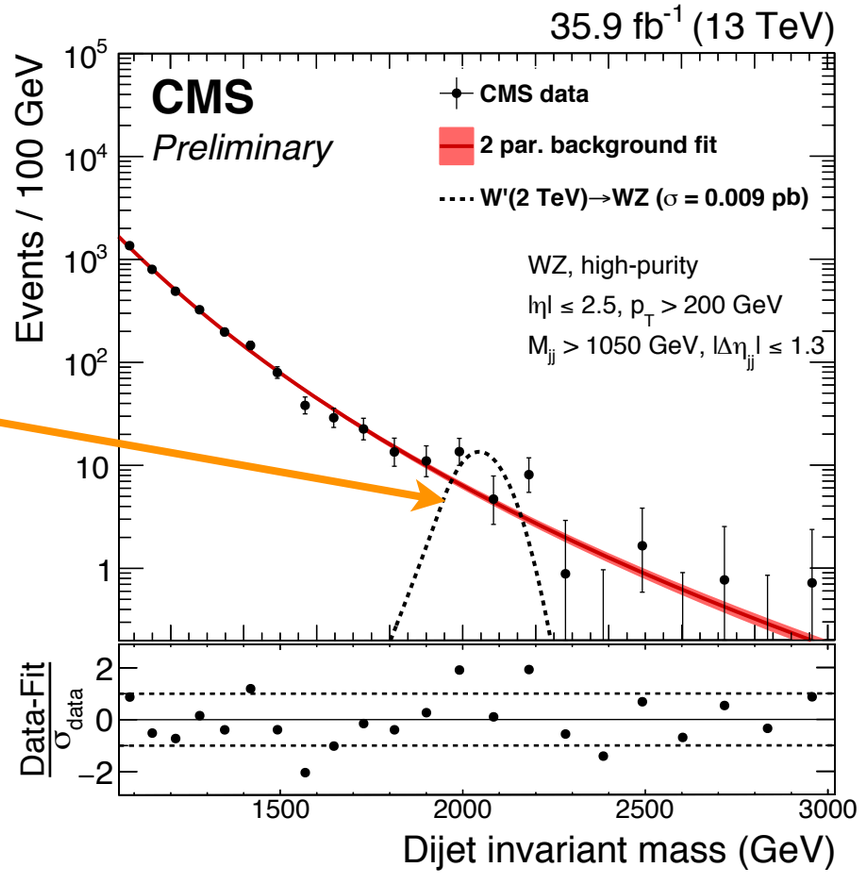



$\tau_{21}$ < 0.35 (HP), 0.75 (LP)

~2σ

6.8 exp 14 obs
/100 GeV

~2x harsher cuts
than 12.9 fb$^{-1}$
(HP selection)

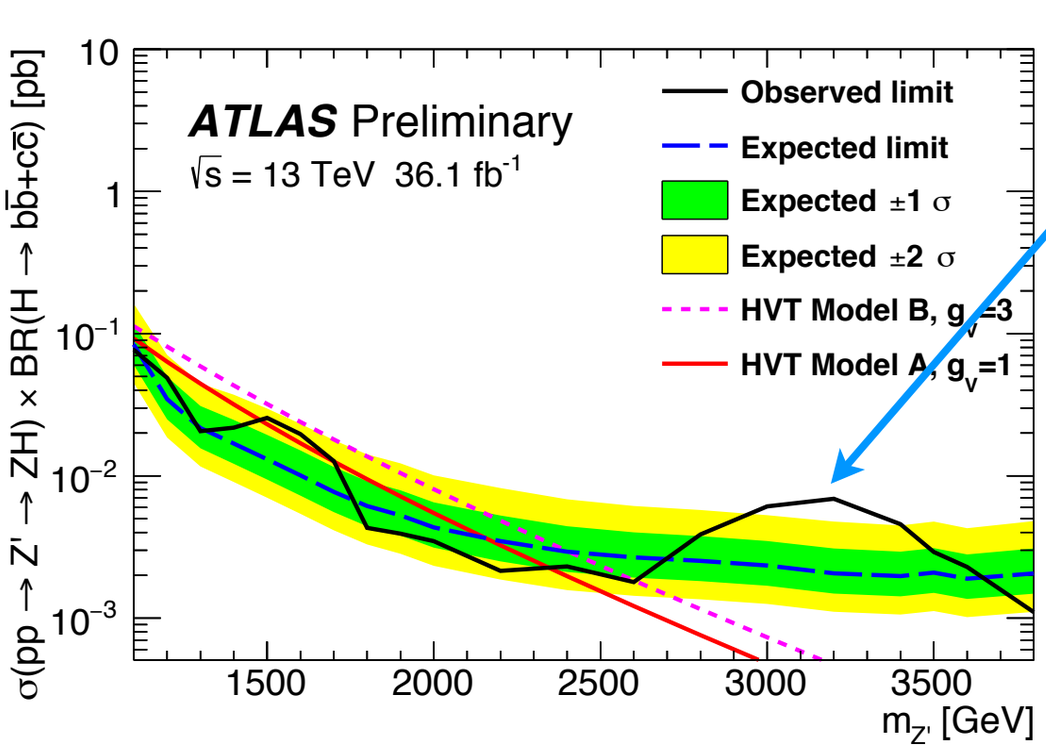


# Just for fun…

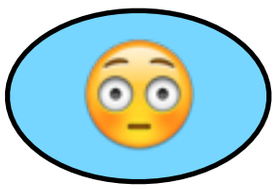
ATLAS-CONF-2017-018
CMS-PAS-B2G-17-002

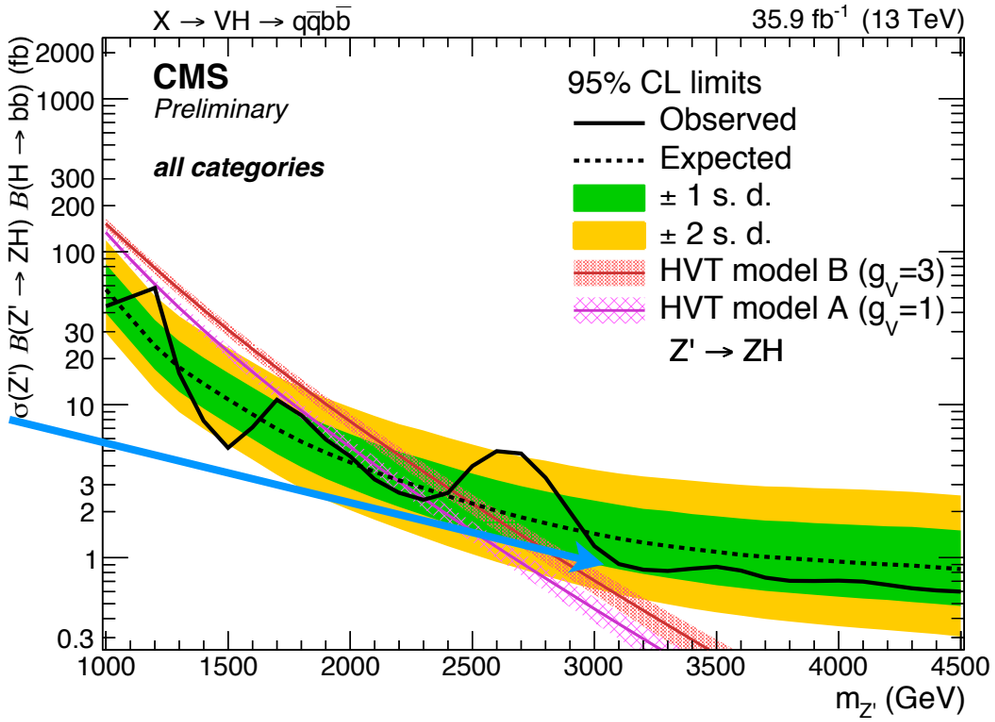
$$M_{Z'} = \frac{\sqrt{2}\,(1)}{\sin\varphi} M_{W'}$$ … is there something near 3.2 TeV?

## Searches for *ZH* resonances




3.3σ






$75 \leq m_H \leq 145$ GeV

$105 \leq m_H \leq 135$ GeV

might ``*H*´´ be an $A^0$ with 100 GeV?

## 3.2 TeV bump is dubious, anyway!

- Only 3 events at the tail… suggestive but not compelling enough.
- Background modeled with power-law tails, might be underestimated.
- `Standard´ $SU(2)_R$ $Z'$ is not leptophobic; limits on $Z' \to \ell\ell$ are one order of magnitude below the $SU(2)_R$ prediction.
- $Z' \to Z\, A^0$ is absent (charge symmetry); $Z' \to Z\, H_1{}^0$ vanishes in the alignment limit.