

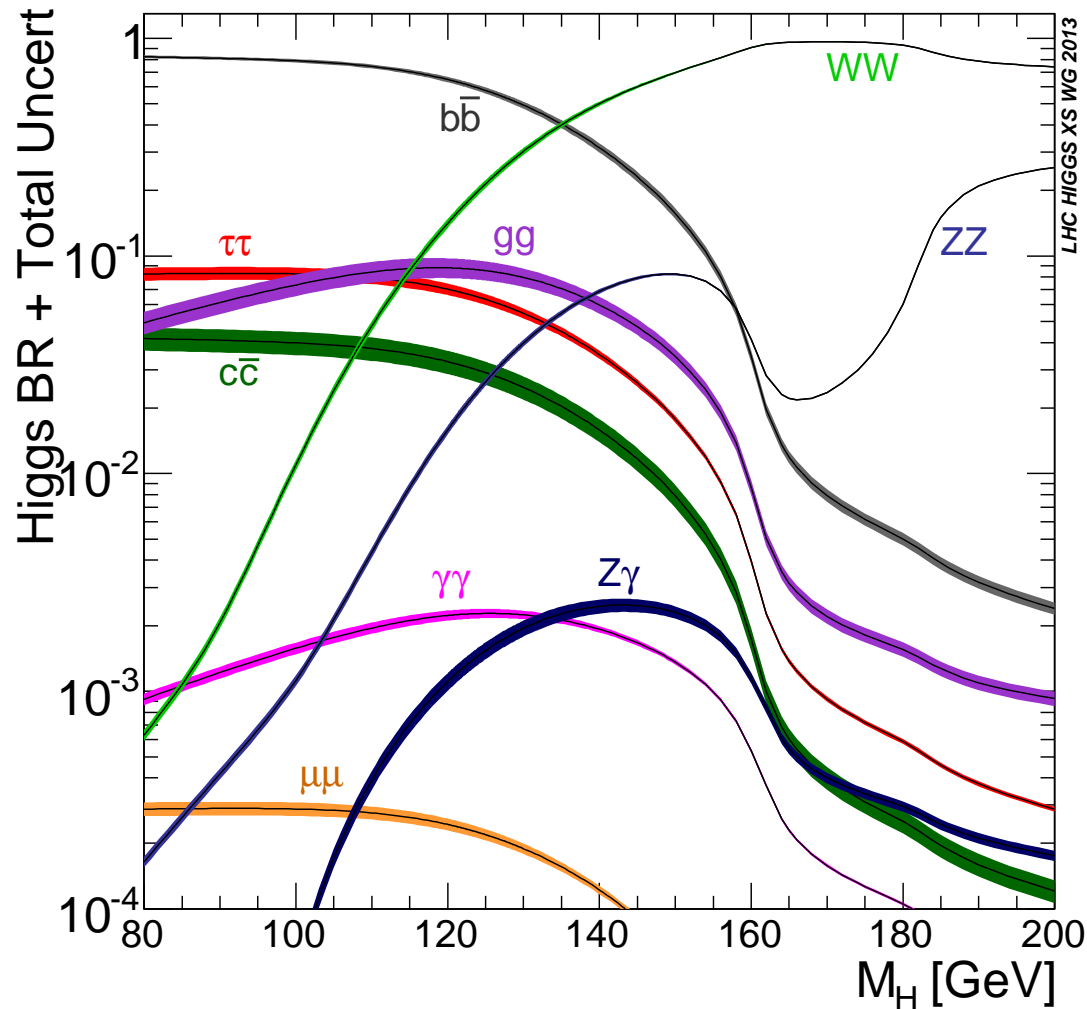
# BR subgroup report

slides for Sven's talk

HXSWG meeting

CERN, January 14, 2016

Branching ratios including error estimates:



⇒ update for  
YR4 around  
 $M_H \sim 125$  GeV

## Global picture for YR4:

- **setup unchanged** for  $M_H \sim 125$  GeV
  - Prophecy4f for  $H \rightarrow 4$  fermions
  - HDECAY for all other channels (now using  $\overline{\text{MS}}$  input masses)
- **Improvements**
  - reduced parametric uncertainties  
(LHCHXSWG-INT-2015-006)
  - improved theory input in HDECAY

⇒ updated central BR values only change well within the YR3 error estimates

⇒ **errors shrink considerably**

Improved **theory uncertainties** for  $M_H \sim 125$  GeV:

- full EW NLO corrections now included in HDECAY

- $H \rightarrow b\bar{b}/c\bar{c}/\tau^+\tau^-/\mu^+\mu^-$  THUs:

YR3:  $\sim 2.0\%$   $\rightarrow$  YR4:  $\sim 0.5\%$

- other channels unchanged

$H \rightarrow gg$ :  $\sim 3\%$

$H \rightarrow \gamma\gamma$ :  $\sim 1\%$

$H \rightarrow Z\gamma$ :  $\sim 5\%$

$H \rightarrow WW/ZZ$ :  $\sim 0.5\%$

## PU and THU impact on partial width errors:

$$M_H = 125 \text{ GeV}$$

YR3  $\rightarrow$  YR4

Channel	$\Delta\alpha_s$	$\Delta M_b$	$\Delta M_c$	THU
$b\bar{b}$	$-2.3\% \rightarrow -1.4\%$	$+3.3\% \rightarrow +1.7\%$	$+0.0\%$	$+2.0\% \rightarrow +0.5\%$
	$+2.3\% \rightarrow +1.4\%$	$-3.2\% \rightarrow -1.7\%$	$-0.0\%$	$-2.0\% \rightarrow -0.5\%$
$\tau^+\tau^-$	$+0.0\%$	$+0.0\%$	$+0.0\%$	$+2.0\% \rightarrow +0.5\%$
	$-0.0\%$	$-0.0\%$	$-0.0\%$	$-2.0\% \rightarrow -0.5\%$
$\mu^+\mu^-$	$+0.0\%$	$+0.0\%$	$+0.0\%$	$+2.0\% \rightarrow +0.5\%$
	$-0.0\%$	$-0.0\%$	$-0.0\%$	$-2.0\% \rightarrow -0.5\%$
$c\bar{c}$	$-7.1\% \rightarrow -1.9\%$	$-0.0\%$	$+6.2\% \rightarrow +5.3\%$	$+2.0\% \rightarrow +0.5\%$
	$+7.0\% \rightarrow +1.9\%$	$-0.0\%$	$-6.1\% \rightarrow -5.2\%$	$-2.0\% \rightarrow -0.5\%$
$gg$	$+4.2\% \rightarrow +3.0\%$	$-0.1\%$	$+0.0\%$	$+3.0\%$
	$-4.1\% \rightarrow -3.0\%$	$+0.1\%$	$-0.0\%$	$-3.0\%$
$\gamma\gamma$	$+0.0\%$	$+0.0\%$	$+0.0\%$	$+1.0\%$
	$-0.0\%$	$-0.0\%$	$-0.0\%$	$-1.0\%$
$Z\gamma$	$+0.0\%$	$+0.0\%$	$+0.0\%$	$+5.0\%$
	$-0.0\%$	$-0.0\%$	$-0.0\%$	$-5.0\%$
$WW$	$+0.0\%$	$+0.0\%$	$+0.0\%$	$+0.5\%$
	$-0.0\%$	$-0.0\%$	$-0.0\%$	$-0.5\%$
$ZZ$	$+0.0\%$	$+0.0\%$	$+0.0\%$	$+0.5\%$
	$-0.0\%$	$-0.0\%$	$-0.0\%$	$-0.5\%$

(in YR4 the  $\overline{\text{MS}}$  mass  $m_c(3 \text{ GeV})$  is used as input)

(table is starting point if one wants to include error correlations in BR calculations)



# RWTH SM BRs

$M_H = 125 \text{ GeV}$ :

## Changes for **partial width's central values**

- $\Gamma_{H \rightarrow b\bar{b}}$ : 1.5% increase
- $\Gamma_{H \rightarrow gg}$ : 4% decrease
- other channels: per mille level changes
- $\Gamma_{tot}$ : 0.5% increase

## Changes for **BR's central values**

- $\text{BR}(H \rightarrow b\bar{b})$ :  $\sim 1\%$  increase (3.2% error in YR3)
- $\text{BR}(H \rightarrow gg)$ :  $\sim 4.5\%$  decrease (10.0% error in YR3)
- other channels: per mille level to 1% changes

(> 4.0% error in YR3)

## Improved error estimates in YR4:

- improved  $\Gamma_{H \rightarrow b\bar{b}}$  alone reduces errors in other channels by  $\sim 2\%$

$M_H = 125$  GeV:

- $\pm 1.7\%$  for  $\text{BR}(H \rightarrow b\bar{b})$  ( $\pm 3\%$  in YR3)
- $\pm 2.4\%$  for  $\text{BR}(H \rightarrow \mu^+ \mu^- / \tau^+ \tau^-)$  ( $\pm 6\%$  in YR3)
- $\pm 6.5\%$  for  $\text{BR}(H \rightarrow c\bar{c})$  ( $\pm 12\%$  in YR3)
- $\pm 4.5\%$  for  $\text{BR}(H \rightarrow gg)$  ( $\pm 10\%$  error in YR3)
- $\pm 2.8\%$  for  $\text{BR}(H \rightarrow \gamma\gamma)$  ( $\pm 5\%$  error in YR3)
- $\pm 6.8\%$  for  $\text{BR}(H \rightarrow \gamma Z)$  ( $\pm 9\%$  error in YR3)
- $\pm 2.2\%$  for  $\text{BR}(H \rightarrow WW/ZZ)$  ( $\pm 4\%$  error in YR3)

# BRs at large Higgs mass

Strategy for BRs at large Higgs mass:

- use SM prediction **without EW** corrections
- use **HDECAY** for **all channels**
- use new HDECAY version where **EW corrections** can be **switched off**
- numbers will be available soon



# Fully differential $H \rightarrow 4l$

- Now two event generators available:

- **Prophecy4f** at NLO EW for all  $4l$  final states

Bredenstein, Denner, Dittmaier, Weber [0708.4123]

<http://omnibus.uni-freiburg.de/~sd565/programs/prophecy4f/prophecy4f.html>

- **Hto4l** at NLOPS EW for 4 charged leptons

Boselli, Carloni Calame, Montagna, Nicosini, Piccinini [1503.07394]

<http://www.pv.infn.it/hepcomplex/hto4l.html>

- includes multi-photon emission
- interface using LHE format
- complete **agreement** at NLO EW

# Fully differential $H \rightarrow 4l$

- complete agreement at NLO EW

