



# Off-shell Higgs for LHC Run 2

- experimental view and short/mid term wish-list

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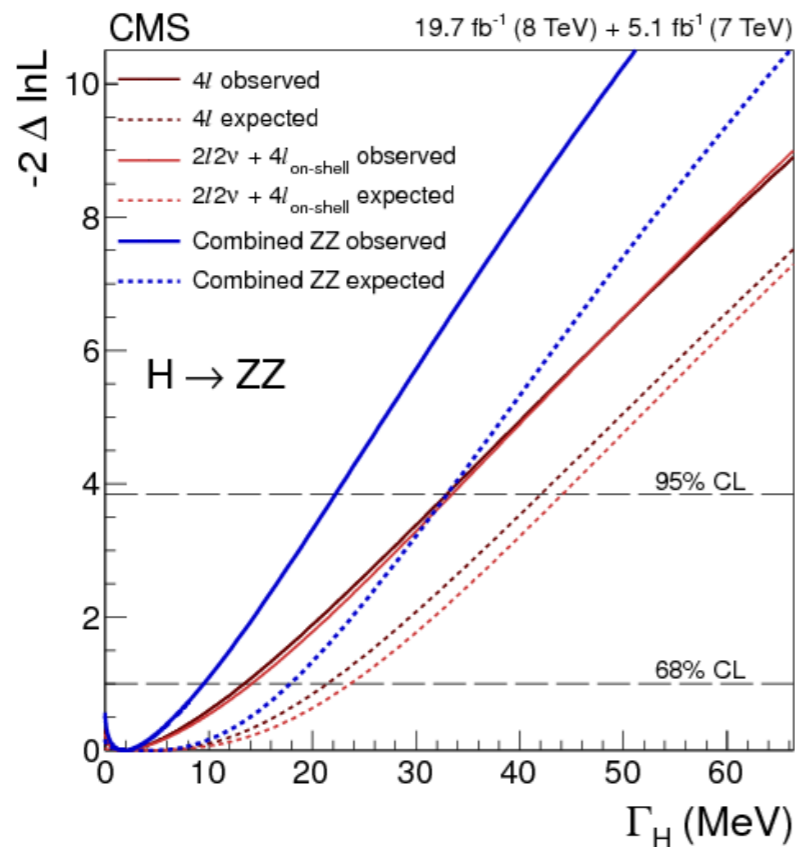
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LHC HXSWG “off-shell Higgs” open meeting

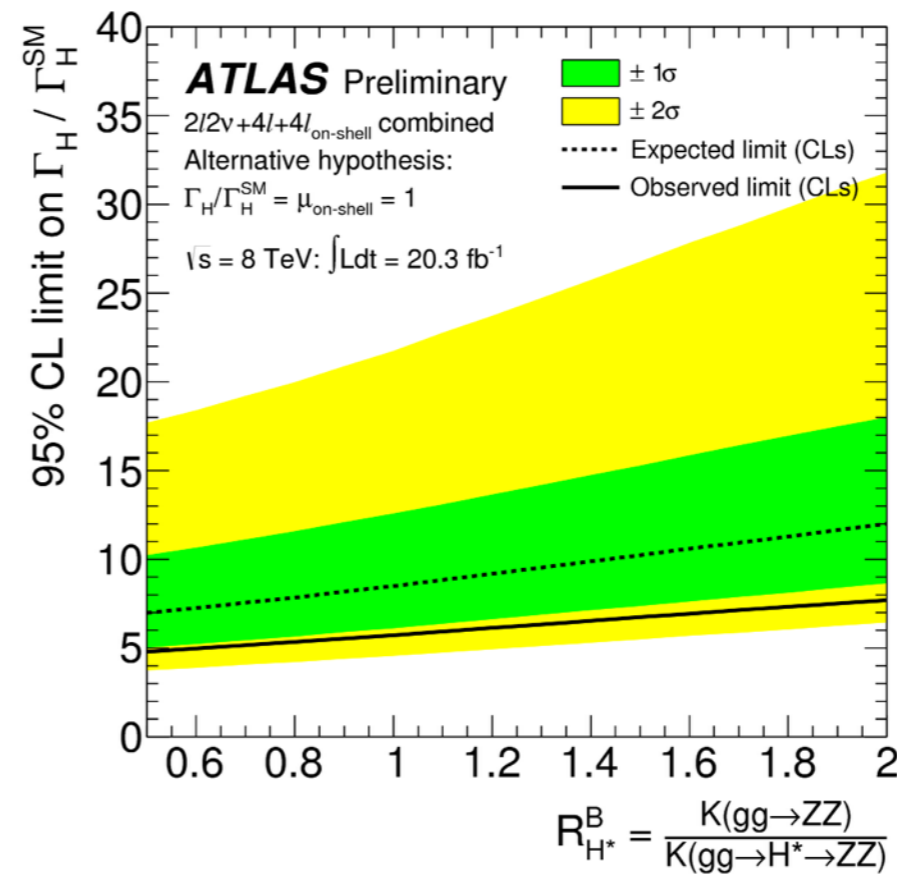
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# What has been achieved

- Phenomenology ideas
  - Kauer, Passarino **JHEP 1208 (2012) 116**
  - Caola, Melnikov **PRD 88 (2013) 054024**; Campbell et al, **JHEP 1404 (2014) 060**
- CMS/ATLAS results on Higgs width constraints using  $ZZ \rightarrow 4l$  and  $ZZ \rightarrow 2l2\nu$  channels (**PLB 736 (2014) 64, ATLAS-CONF-2014-042**)



$$\Gamma_H / \Gamma_H^{\text{SM}} < 5.4 @ 95\% \text{ CL}$$



$$\Gamma_H / \Gamma_H^{\text{SM}} < 4.8 \sim 7.7 @ 95\% \text{ CL}$$

(depending on  $gg \rightarrow VV$  background K factor)

# To sharpen the Higgs width constraints

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- Analyses will surely be repeated in Run 2
  - $H \rightarrow ZZ \rightarrow 4l$  channel is statistical limited
- Constraints on the Higgs width **with VBF only**
  - **No loop contribution - model independent (?)**
  - 20/fb @ 8TeV, VBF  $ZZ \rightarrow 2l2\nu$  channel sets a limit of  $\sim 40 \times \text{SM Higgs width}$  (**CMS-PAS-HIG-14-002**); VBF WW could be competitive here
  - Better S/B; theoretical uncertainties better understood (e.g. background K factor); but still ggH contamination
  - Much larger statistics in Run 2; could combine all ZZ, WW channels

# gg->VV @ NLO and jet binning

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- **K factor of gg->VV** background and consequently interference unknown
  - Currently using signal K factor with residual uncertainties (Passarino, **EPJC 74 (2014) 2866**, Bonvini et al, **PRD 88 (2013) 3, 034032**)
  - Prospect of approximation and uncertainties
    - **What do we do for 13 TeV**
- Reliable description of **jet multiplicity/pT(VV)**
  - Jet binning/veto unavoidable in H->WW analysis, in order to suppress top backgrounds
  - ggH+2jet contamination in VBF channel
  - **Suggestion about uncertainty estimation?**

# To constrain Higgs properties in EFT

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- New ideas using off-shell production?
  - Yes, they are popping up, e.g. **1406.6338**, etc
  - Status of MC tools to facilitate analyses
  - Dedicated talks today
- What is feasible/ should be prioritized in the Run 2
- In long run, what is the additional/complementary physics reach compared to on-shell measurements?