

WW Signal Definition

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Introduction

- ▶ Purpose of the talk is to summarize the WW signal definition in CMS
- ▶ Three main processes with two W boson pairs in the final state:
 - ▶ $qq' \rightarrow WW$
 - ▶ $gg \rightarrow WW$
 - ▶ $gg \rightarrow H \rightarrow WW^*$
- ▶ Most updated results:
 - ▶ SMP-12-005: 7 TeV
 - ▶ SMP-14-016: 8 TeV
 - ▶ SMP-16-006: 13 TeV
- ▶ Usual theory cross section computations split in WW and $H \rightarrow WW^*$, e.g. arXiv:1408.5243 for WW
 - ▶ quoted at NNLO QCD
 - ▶ $gg \rightarrow WW$ considered at LO

Signal Definition

- ▶ $qq' \rightarrow WW$ & $gg \rightarrow WW$ considered “signal”, while $gg \rightarrow H \rightarrow WW^*$ considered “background”
- ▶ Want to quote non-resonant WW cross section
- ▶ Selection designed to reject relatively soft leptons, including $H \rightarrow WW^*$ events
 - ▶ $N_{H \rightarrow WW^*} / N_{WW} \sim 4\%$
 - ▶ even tighter selection at $\sqrt{s} = 13$ TeV
- ▶ Very different selection efficiencies
 - ▶ would need to fix the ratio to quote the $WW+H \rightarrow WW^*$ cross section, not so important aspect if selection efficiencies were similar
- ▶ A simultaneous fit to measure WW and $H \rightarrow WW^*$ cross section is an option, although it requires a much more complicated analysis strategy
 - ▶ a cut-and-count approach is not good enough to measure $H \rightarrow WW^*$ contribution

- ▶ $gg \rightarrow WW$ process relatively small, but tricky to be considered
- ▶ NLO calculation for this process exists including interference effects with $gg \rightarrow H \rightarrow WW$, see Arxiv:1605.04610
- ▶ Nevertheless, not matched to a parton shower so far
- ▶ Therefore, these are the used cross sections at 13 TeV in CMS following those considerations:
 - ▶ $\sigma_{qq \rightarrow WW} = (118.7 - 3.974) \text{ pb (@NNLO)}$
 - ▶ $\sigma_{gg \rightarrow WW} = (3.974 * 1.4) \text{ pb (@NLO)}$
 - ▶ $\sigma_{gg \rightarrow H \rightarrow WW^*} = (48.580 * 0.2150) \text{ pb (@NNNLO)}$

Fiducial Cross Section Definition

- ▶ Since analysis is partially limited by theoretical uncertainties, it would be good to quote a cross section in an agreed fiducial region
- ▶ Possible definition:
 - ▶ two leptons with $p_T > 25$ GeV with $|\eta| < 2.5$
 - ▶ which kind of leptons? personal preference:
electrons/muons/taus after (or before) FSR with no further corrections
 - ▶ no jets with $p_T > 30$ GeV with $|\eta| < 5$
- ▶ Does it work for everyone? can this be agreed?

Signal Theoretical Corrections

- ▶ Theoretical corrections on plain signal MC samples are most of the time a mystery outside the collaborations
- ▶ Two main corrections on the market for WW:
 - (1) p_T^{WW} reweighting to QCD NNLO, see e.g. [ArXiv:1606.01034](#)
 - (2) EWK corrections, see e.g. [ArXiv:1605.03419](#)
- ▶ (1) used in CMS, (2) not included mostly because the effect is tiny on the bulk
- ▶ Effect of (1) is rather small with our current powheg default MC generator, it was very important with the old 8 TeV madgraph sample
- ▶ Can these corrections be agreed?