Treatment of gg->ZH in Higgs combinations

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on behalf of the ATLAS collaboration

Thanks to C. Englert, M. McCullough, M. Spannowsky, G. Piacquadio, P. Rose, M. Duehrssen W. Verkerke

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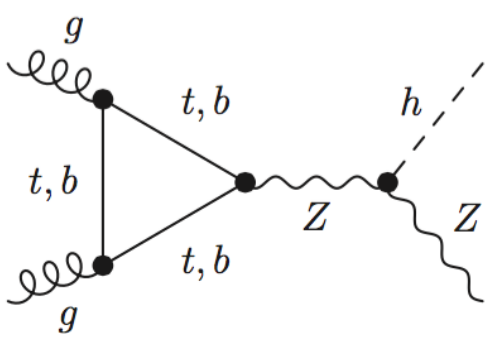
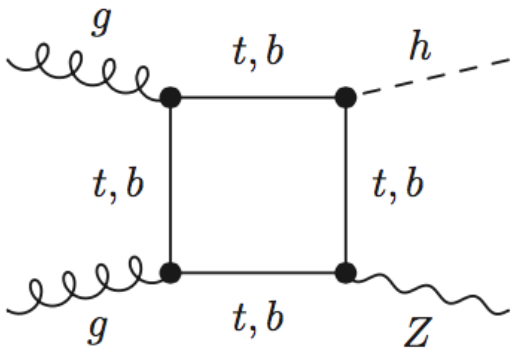
ggZH in coupling measurements





- Recent results in ATLAS-CONF-2015-007 incorporate ggZH
  - Combination of ATLAS Higgs measurements at 7,8 TeV
  - Aim for measurements of signal strengths & constraints on Higgs couplings
  - Interference in gg->ZH process uniquely probes relative sign of κ_t and κ_Z
- Relative contribution of ggZH to ppZH varies with Z pT
  - ATLAS splits the VH(bb) analysis into distinct V pT bins
- Parameterize the cross section in terms of the κ coupling factors
  - Derive scaling factors to multiply inclusive cross sections (Altenkamp et al.)
  - Start from $1 - 0.91\,\delta t + 0.37\,\delta t^2 - 1.64\,\delta t\delta v + 2.90\,\delta v + 2.27\,\delta v^2$ (8 TeV result from Englert et al. following arXiv:1310.4828)

Fits to LoopTools calculations

- Thanks to Christoph, Matthew, Michael for use of their FeynCalc/ LoopTools + VBFNLO implementation with LHE output
  - LHE output is essential for restricting the particle-level phase space to match experimental measurement phase space (mass, pT) independent of decay
  - Ex.: dilepton mass in [71,121 GeV]; 2 pT(Z) bins: <120 and >120 GeV
  - Kinematic requirements applied in simple Pythia analysis after radiation
- Calculate ggZH cross section with variations in $\delta t=\kappa_t-1$ and δV parameters and fit dependence up to quadratic order in δt and δV
- Interesting comparison with inclusive cross section dependence:

  8 TeV inclusive: $1 - 0.91\,\delta t + 0.37\,\delta t^2 - 1.64\,\delta t\delta v + 2.90\,\delta v + 2.27\,\delta v^2$
  8 TeV pT<120: $1 - 0.69\,\delta t + 0.16\,\delta t^2 - 1.06\,\delta t\delta v + 2.65\,\delta v + 1.79\,\delta v^2$
  8 TeV pT>120: $1 - 1.21\,\delta t + 0.63\,\delta t^2 - 2.50\,\delta t\delta v + 3.21\,\delta v + 2.84\,\delta v^2$

- Effect of coupling variations is enhanced at high Z pT, as expected

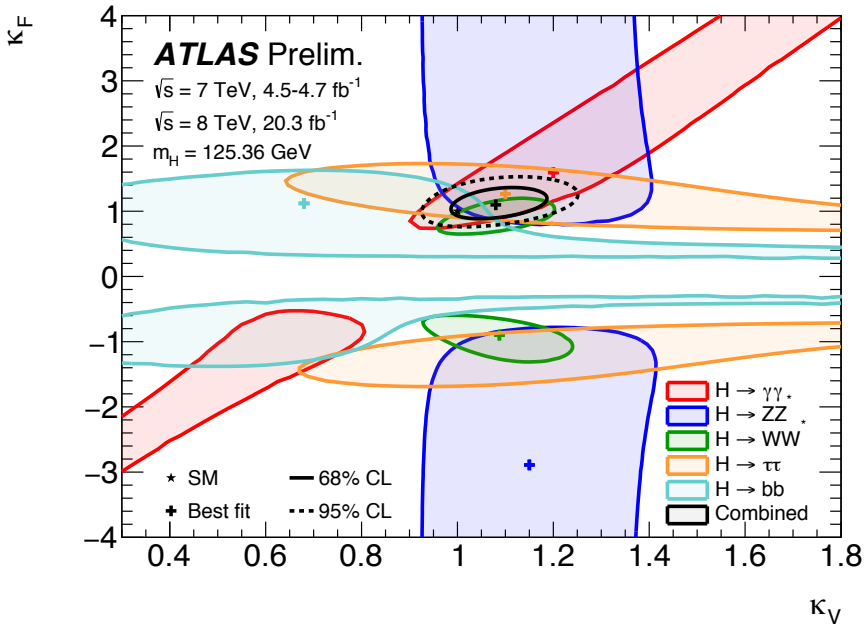
Treatment of ggZH in combination

- How to treat the ggZH contribution in overall combination?
  - What uncertainties are used, and how are they correlated?
  - Each bin in Z pT is treated as a separate "mini-channel"
- Theory uncertainties
  - PDF uncertainties anti-correlated between qq->ZH and gg->ZH channels
  - Scale uncertainties correlated between qq->ZH and gg->ZH samples
  - No uncertainty incorporated for coupling parameterizations(?)
- Experimental uncertainties
  - All treated as correlated between pT bin "mini-channels" and correlated as appropriate with other channels

- Maybe there is some more discussion needed on how to:
  - Calculate uncertainties and determine correlations (in specific phase space!)
  - Compare results from several tools and groups

Summary

- gg->ZH contributions parameterized as function of couplings in specific experimental phase space
  - Strong dependence on Z pT, as expected
- Cross section effect propagated to signal numbers for VH channels
- Expect high levels of correlation, with exception of PDF uncerts.
- Other topics to discuss?



ATLAS-CONF-2015-007