Higgs trilinear and quartic couplings

Low Mass Higgs Meeting, April 13, 2012, R. Tanaka (LAL)

- Higgs self-coupling measurement is the highest priority issue in LHC high-luminosity (3 ab^{-1}/EXP) and energy-upgrade (30 TeV) scenario.
- The past study was done with $gg \rightarrow HH \rightarrow WWWW$ at LO with $M_H = 2M_W$.
  - Light Higgs of M_H=125GeV opens many possible channels.
  - We know background conditions much better now with real LHC data.

A. Djouadi et al., EPJ **C10** (1999) 45

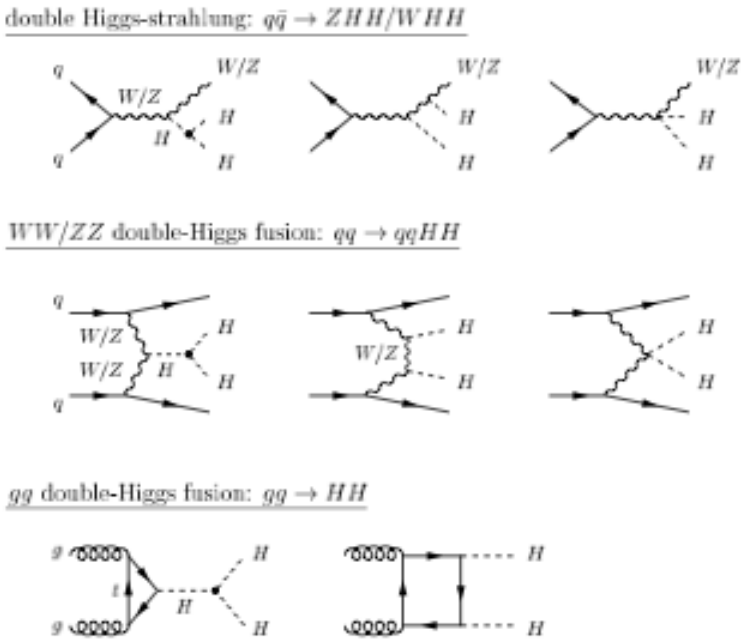

Fig. 1. Processes contributing to Higgs-pair production in the Standard Model at the LHC: double Higgs-strahlung, WW/ZZ fusion, and gg fusion (generic diagrams)

T. Plehn, M. Rauch, PR**D72** (2005) 053008

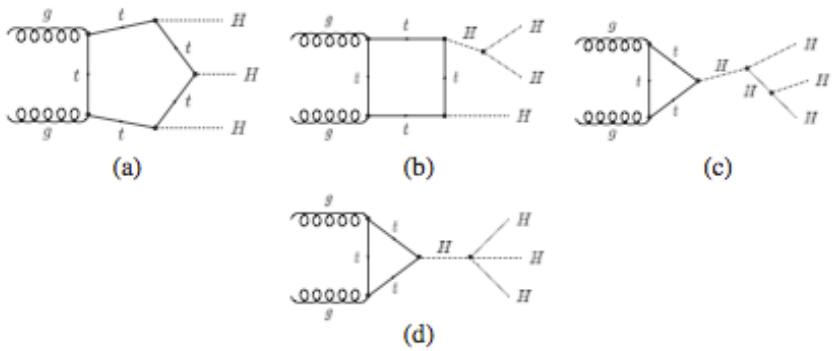

FIG. 1. Examples of Feynman diagrams contributing to the process $gg \rightarrow HHH$.

Questions on theoretical issues and tools

1. Cross sections for gg→HH,HHH, qq→qqHH and qq→WHH/ZHH at 14/30 TeV.
   - The past studies were done in LO, but we would like to profit at least NLO gg→HH cross sections with K-factor of about 1.9 for M_H=125 GeV.
   - Cros sections are available with HPAIR (M. Spira) for gg→HH, and also for other process.
   - Could NNLO(+NNLL) cross section of gg→HH, HHH be obtained in analogy to gg→H (+25% NNLO/NLO) ? But it is known that the EFT overestimates the cross section…
2. QCD scale and PDF uncertainties (with modern PDF set) should be calculated.
3. What are the best parametrization of trilinear/quartic coupling in the presence of box-diagrams (trilinear) and hexagon-, box- and triangle-diagrams (quartic) ?
4. MC simulation tools for the signal gg→HH,HHH, qq→qqHH and qq→WHH/ZHH ?
   - MadGraph 5 (F. Maltoni et al.) can simulate at tree-level of these processes.
5. Are there irreducible backgrounds on which we must rely the theoretical predictions whose caclulations are missing today ?
   - Help from our NLO MC subgroup is highly appreciated.

It would be nice to have agreed cross sections with associated uncertainties and MC tools, along with recommended parametrization for Higgs self-coupling.