Vector - Boson - fusion

Why VBF?

* 2nd largest xsec @ LHC
* Direct access to WWH and ZZH couplings
  -> Test of SM
  -> Unitarity?

* Distinctive Experimental signature
  -> 2 forward jets
  -> Little central jet activity

* Allows to tag candidate H-events
  -> Reduce backgrounds
  -> Search for rare decays.

* $H_{T} \neq 0$ @ LO
  -> cf. ggF.
  -> Easier to find invisible decays with large $E_{T}$.

VBF is buried under ggF.
Can distinguish VBF and ggF by looking at radiation pattern.

⇒ Require 2 forward jets and little central jet activity.

⇒ VBF cuts: e.g.
- at least 2 jets with $p_T > 25 \text{ GeV}$
- 2 hardest jets
  $|y| < 4.5$, $\Delta y_{jj} < 4.5$, $p_T^{jj} > 600 \text{ GeV}$

⇒ After VBF cuts, contamination from ggF reduced to $\sim 10\%$.
VBF @ NNLO would require pentaboxes with internal masses.

Approximation: No color exchange between upper and lower line (Form factor approach).

Each blob is a DI form factor.

* Exact @ LO and NLO

Color does not match at NLO?

Diagram must vanish.

More formally:

$$T_{i_1 i_2} T_{i_3 i_4} S_{i_1 i_2} S_{i_3 i_4} = \text{Tr} (i^2)^2 = 0$$
Beyond NLO, these diagrams are suppressed by color and kinematics:

- By color:

\[ \sim N_c^2 \]

- By kinematics: emissions are preferentially in the direction of the emitter (cf. angular ordering)

\[ \implies \text{large angle emission suppressed} \]

VBF is known in the form factor approach @ NNLO

- inclusively \( \sim \) small corrections
- differentially \( \sim \) up to 10% corrections after VBF cuts.