

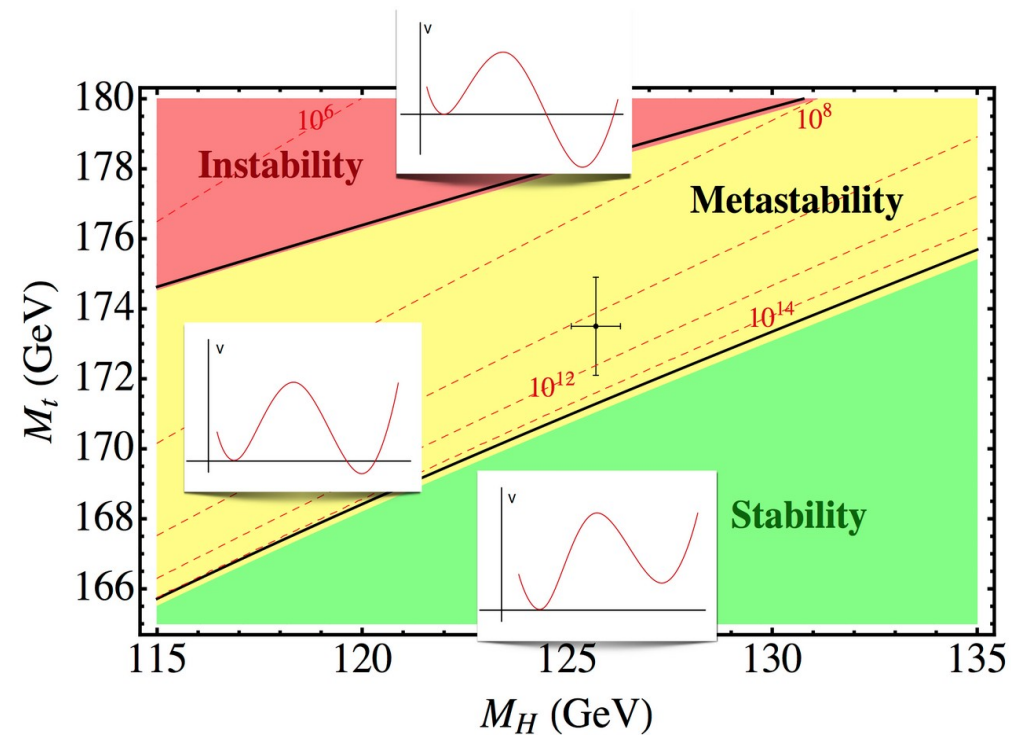
The Higgs and the 7 Tops

Reinhild Yvonne Peters
The University of Manchester



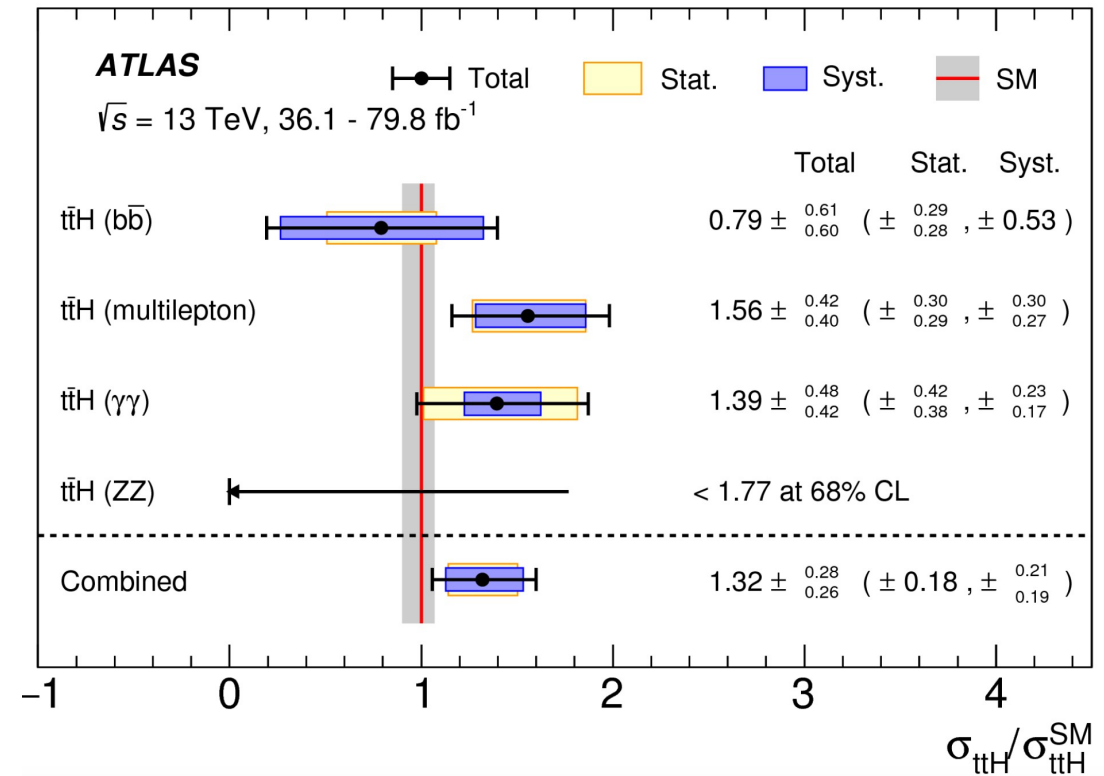
Top-Higgs: Motivation

- ◆ Measure top-Higgs Yukawa coupling directly
 - special role of top quark in EW symmetry breaking?
 - window to new physics?
- ◆ Probe for CP odd components in the Higgs sector
 - CP violation?
- ◆ More than one Higgs bosons?
 - 2HDM?



Top Yukawa Coupling

- ◆ Already achieved: First observation of $t\bar{t}H$ (CMS, and ATLAS)



- ◆ How to go on?

- More of $t\bar{t}H$
- Dedicated search for tHj
- Explore also 4top-events

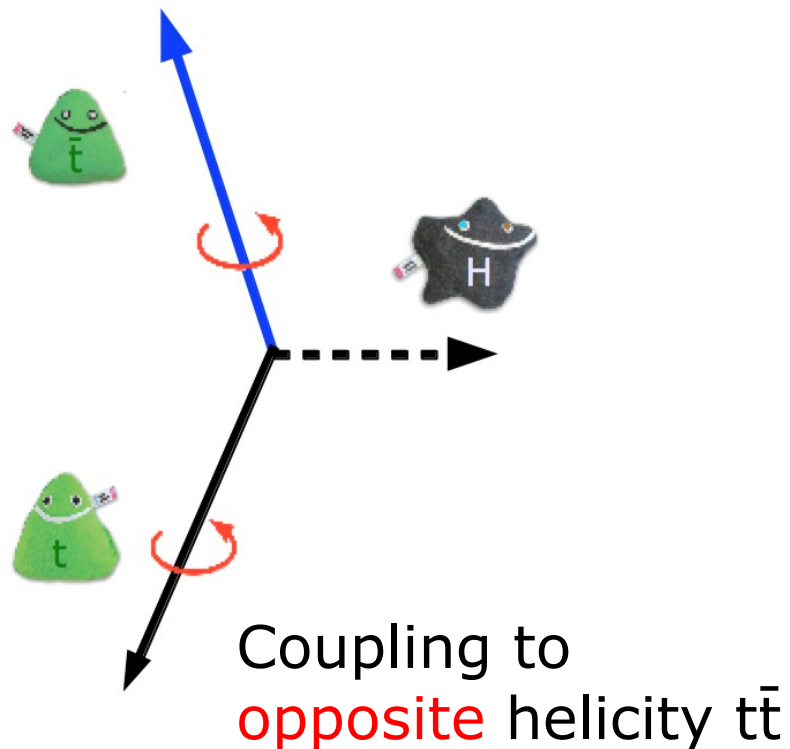
→ all processes with Higgs-Top interaction

- But all very challenging on their own

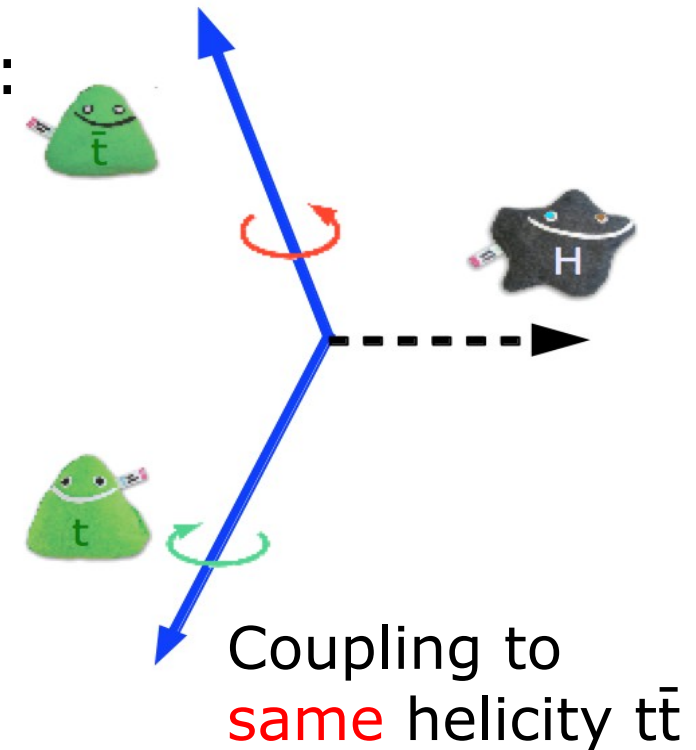
Odd Higgs

- ◆ CP violation required for Sakharov conditions
 - mixing with CP odd necessary
 - CP odd component in Higgs sector?

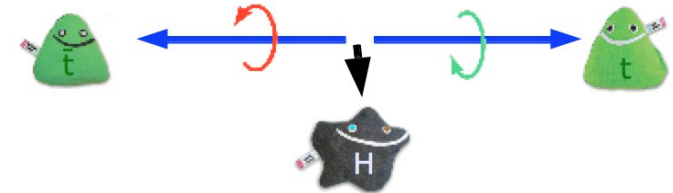
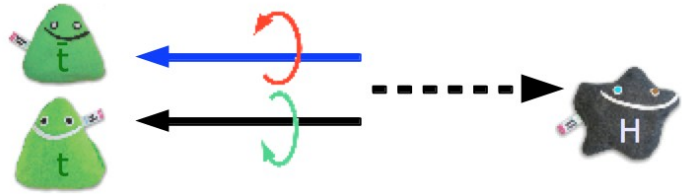
CP odd:



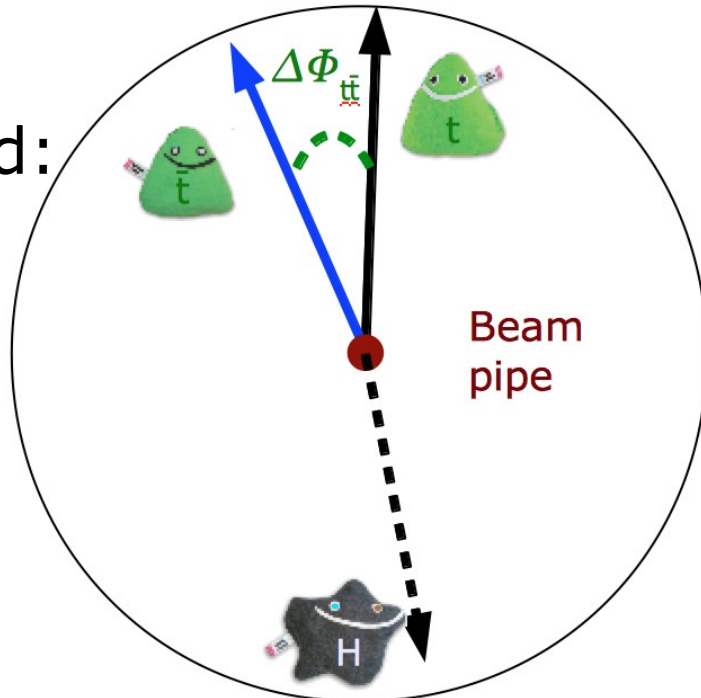
CP even:



Odd Higgs

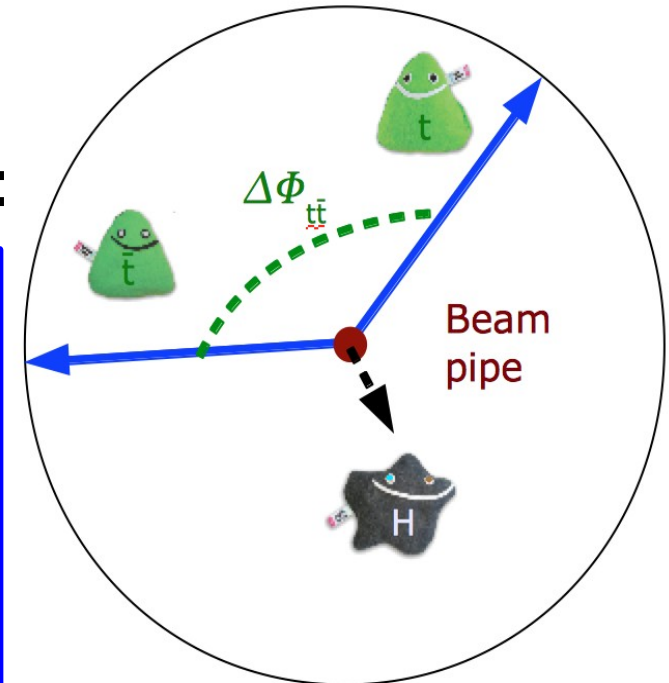


CP odd:

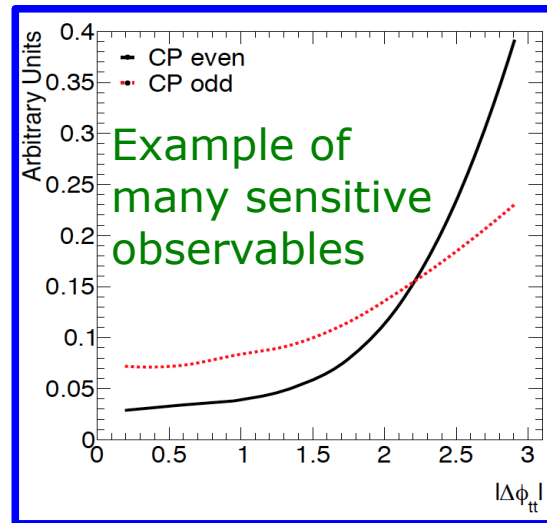


Coupling to
opposite helicity $t\bar{t}$

CP even:

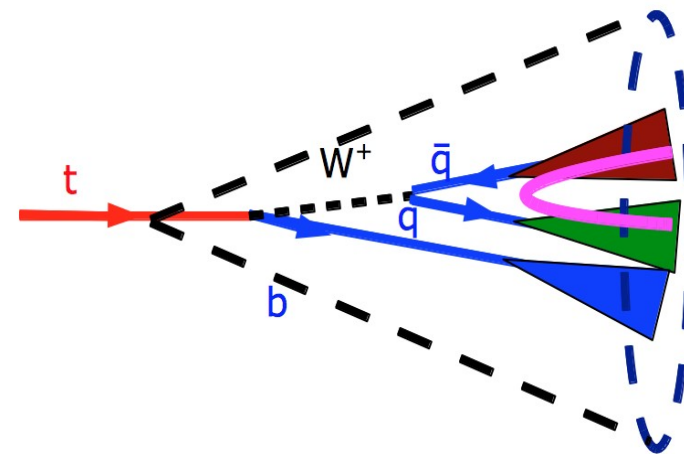
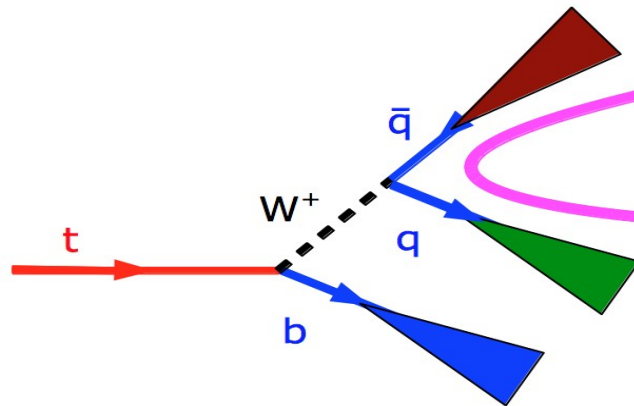


Coupling to
same helicity $t\bar{t}$



CP: Ingredients

- ◆ Required: spin-sensitive variables, like angular variables
- ◆ For some channels (like dilepton $t\bar{t}H$, $H \rightarrow bb$): specific event-reconstruction methods
- ◆ Ideally:
 - resolved and boosted regimes
 - Many different final states

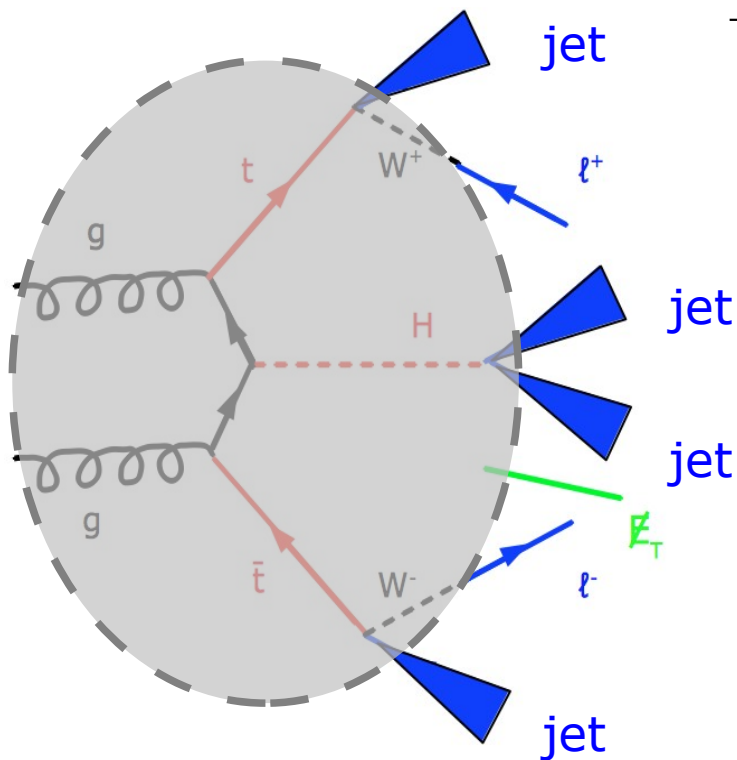


Reconstruction

Detector: only final state objects can be reconstructed

- Neutrinos not detected, only missing transverse momentum
- Object-pairings unknown

→ **very challenging** to extract event information!



Not visible
with detector

Visible
objects

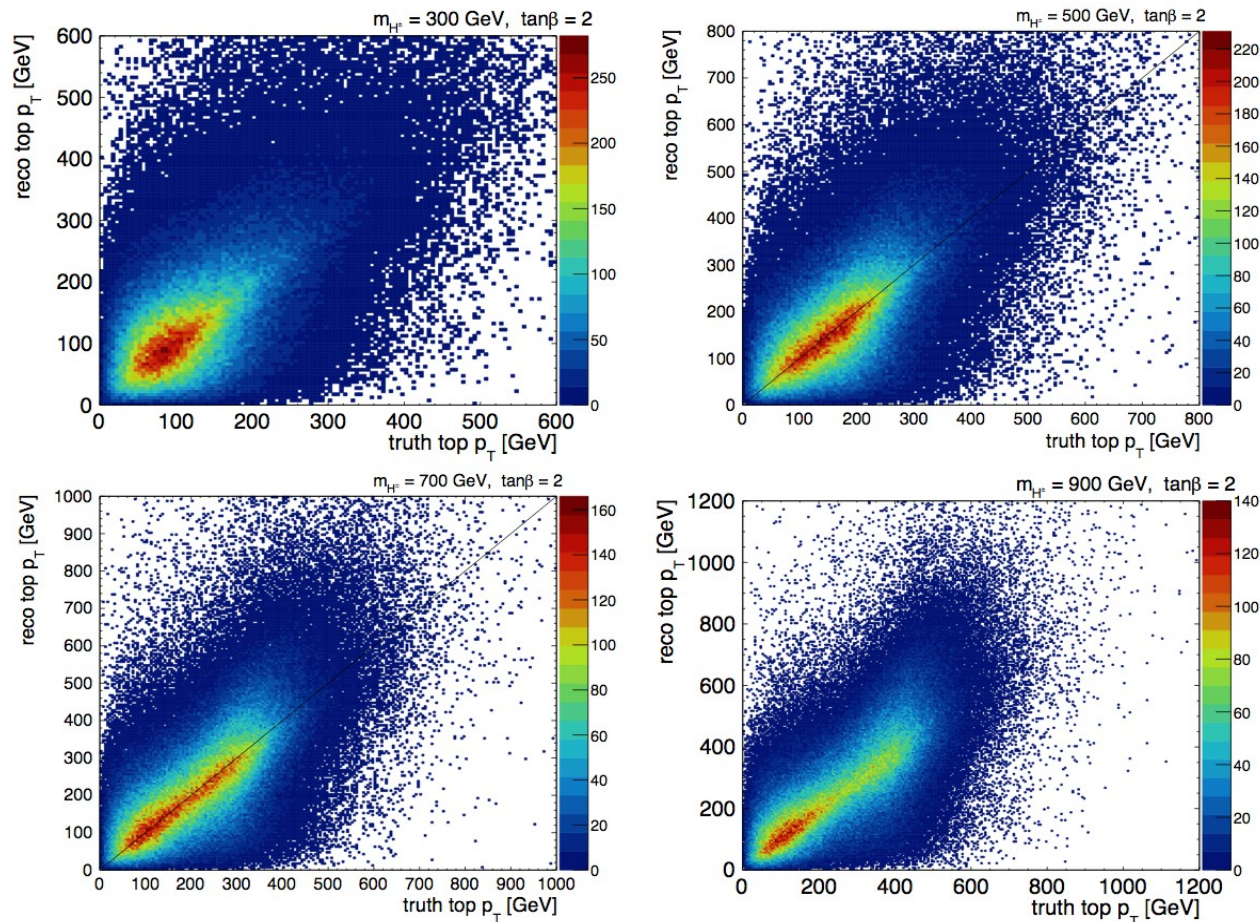
Two main challenges:

- Sorting of permutations
- Calculation of **4-momenta for neutrinos**

- ◆ Already existing expertise in neutrino weighting ($t\bar{t}$) can be used

Reconstruction

- ◆ Our paper on heavy H^+ (on arxiv since yesterday):
First success to develop BDT+neutrino weighting reconstruction approach for $\bar{t}t\bar{b}b$ final state

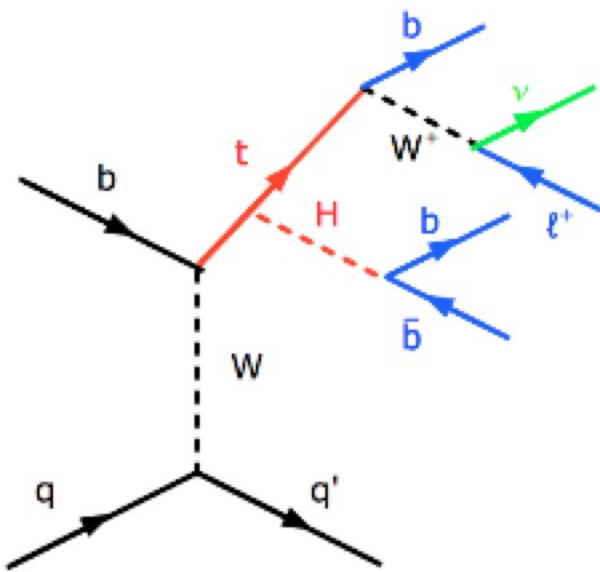


arXiv:1812.04713

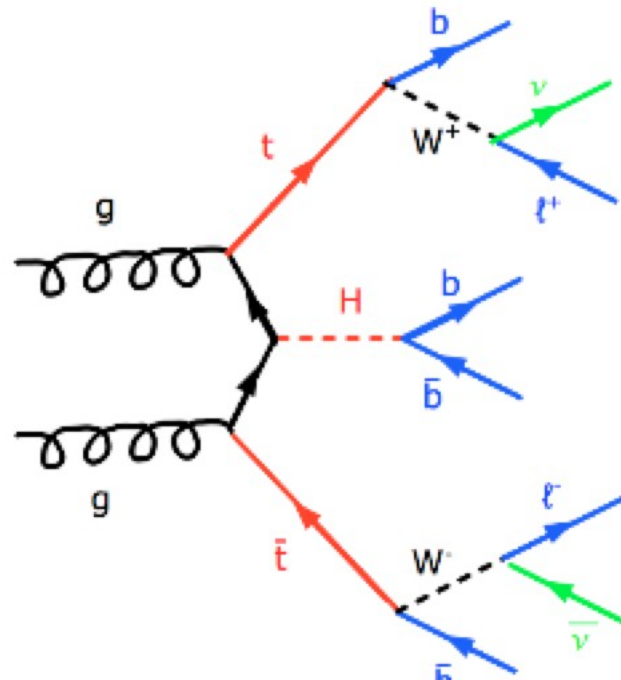
"My" channels

- ◆ My project: concentrate on $H \rightarrow b\bar{b}$ decays only
 - Pure 3rd generation fermionic couplings
 - Also motivated by MS-2HDM models

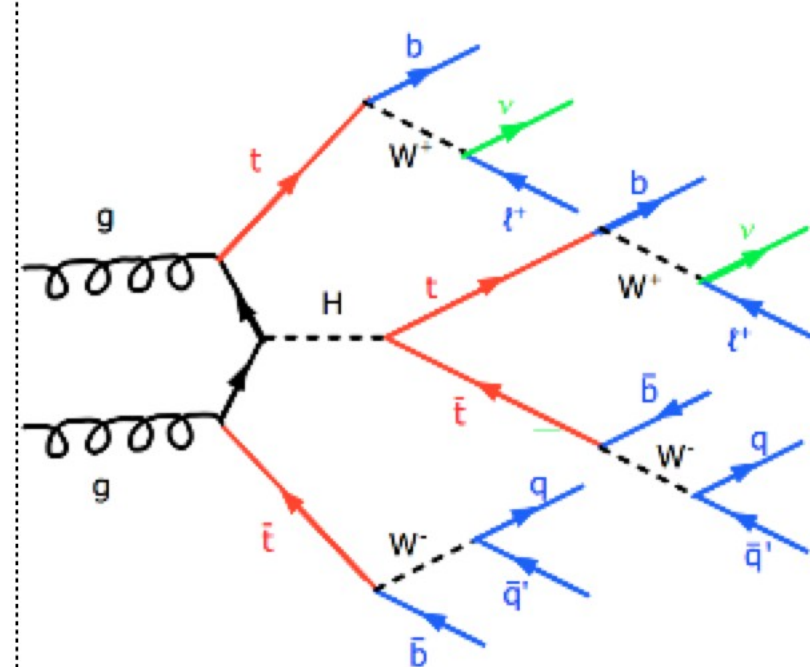
thj channel



t̄th channel

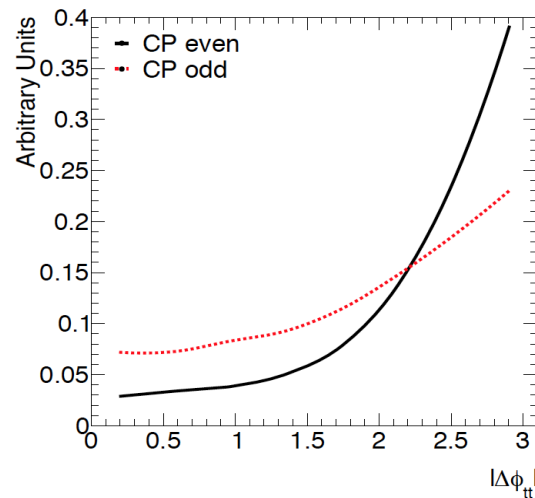


t̄t̄t̄ (4top) channel

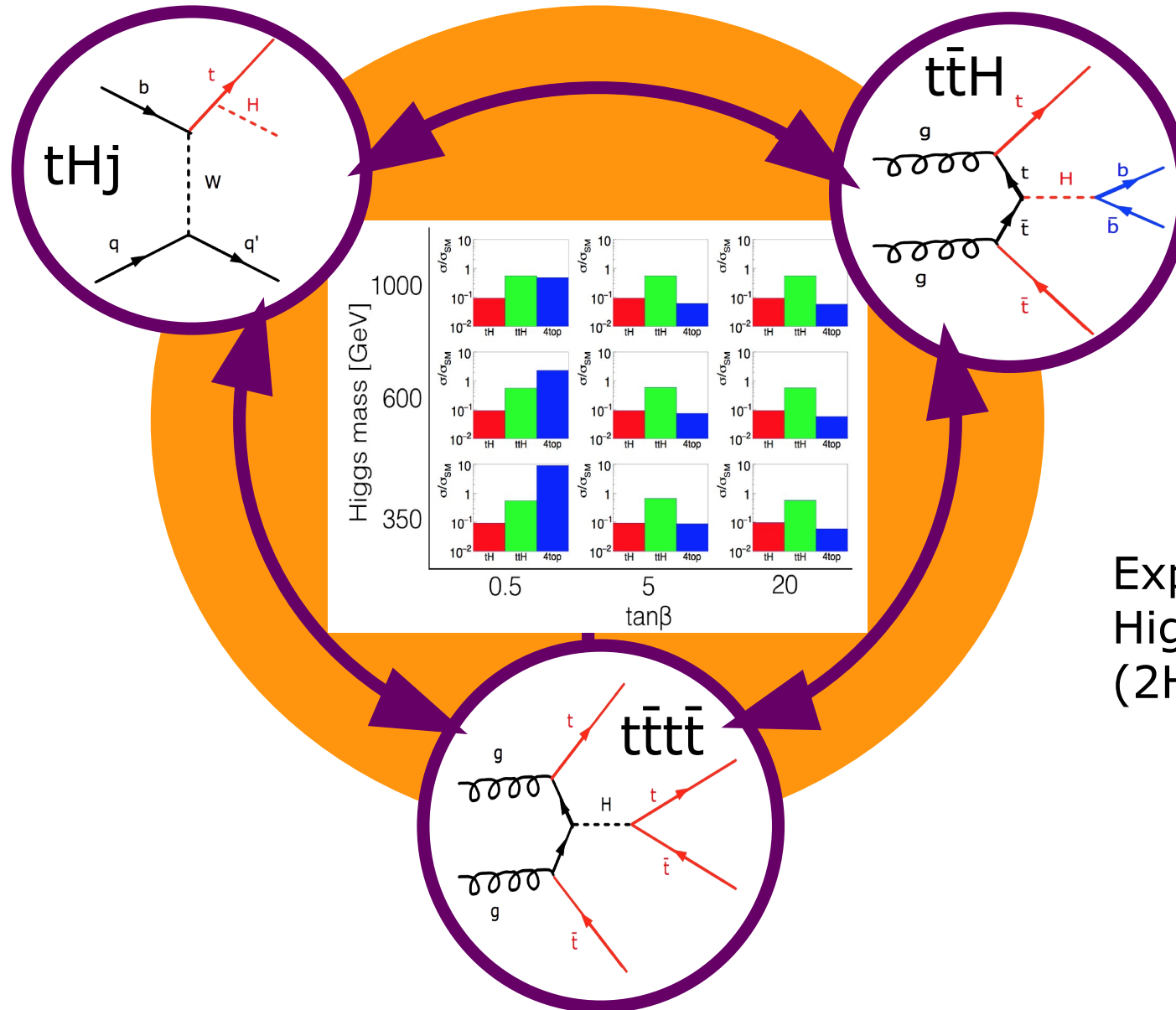


Project

- ◆ First step: analyse all processes separately
 - Requires group-efforts (e.g. on modeling of backgrounds)
- ◆ Next step: extract CP-sensitive variables
 - angular/asymmetry variables. Input from theorists always welcome
 - Try differential distributions
 - Combinations!



The Higgs And The 7 Tops



Explore extended Higgs sectors (2HDM)

Summary

- ◆ Explore Top-Higgs connection at best possible precision
 - Yukawa coupling: magnitude/sign
 - CP odd components
 - Models with >1 Higgs

- ◆ My project: concentrate on $H \rightarrow b\bar{b}$; dileptonic $t\bar{t}H$
 - Collaboration with similar analyses in other channels **very** welcome

- ◆ Theory collaboration would be beneficial :)

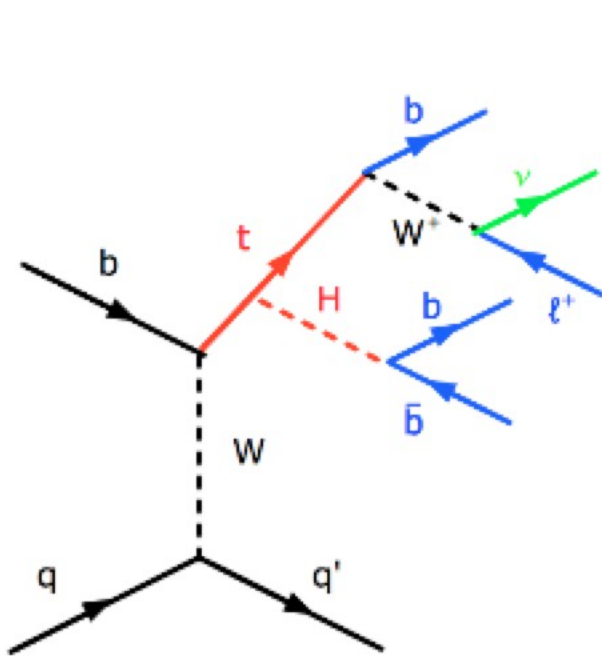
- ◆ Loads of room for extensions/collaborations/...



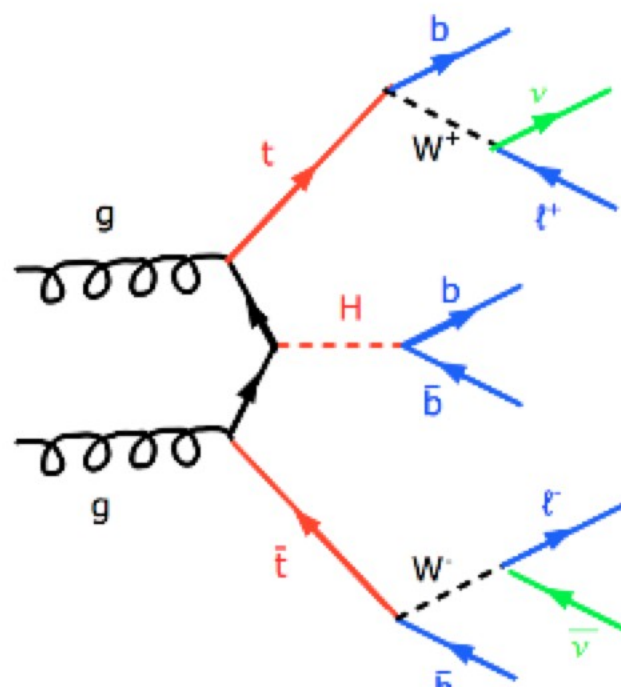
Backup

The Channels

thj channel



$t\bar{t}h$ channel



$t\bar{t}t\bar{t}$ (4top) channel

