

Searches for Higgs decays to invisible final states at CMS

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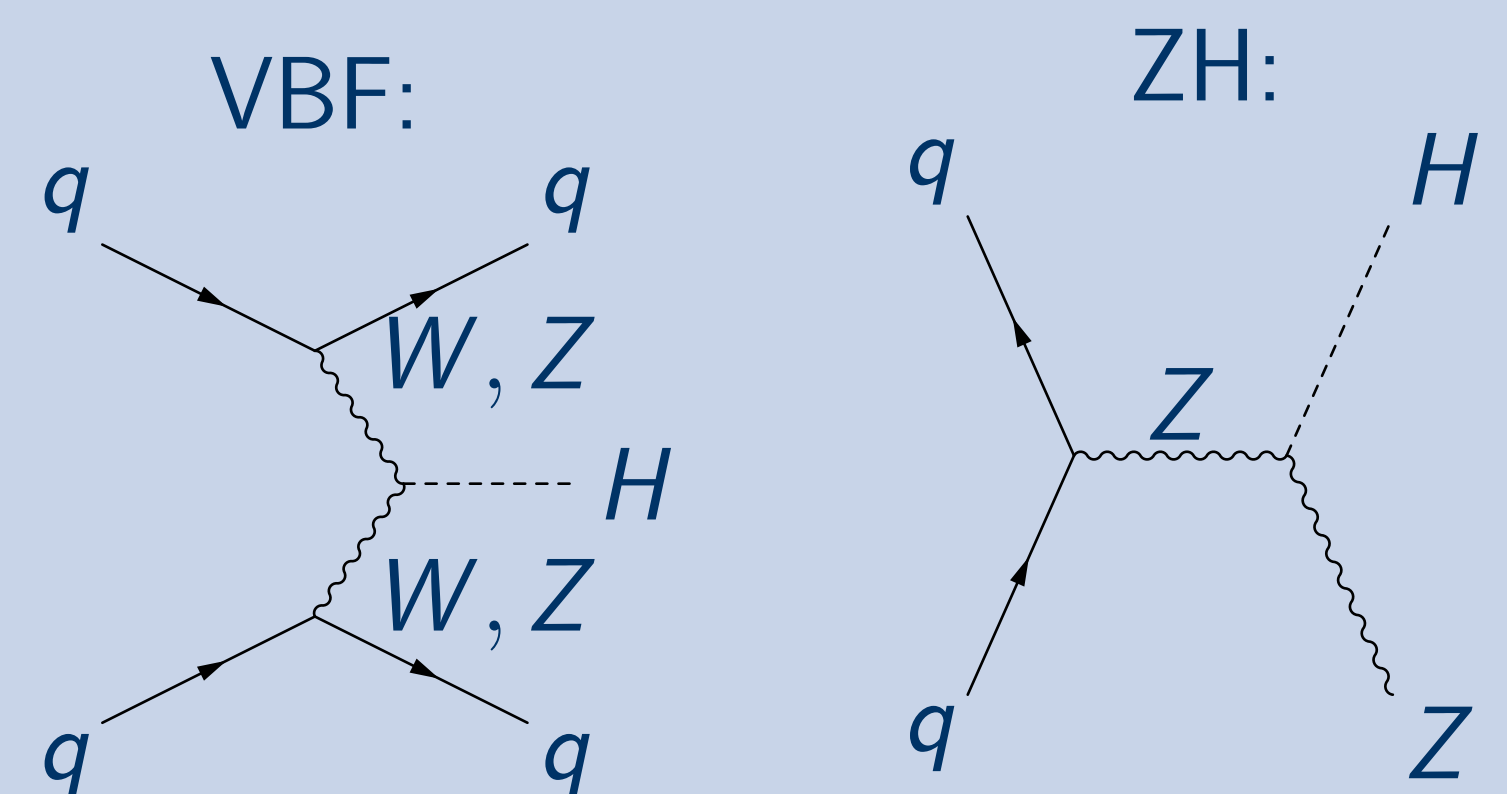
Why Higgs to invisible?

- ▶ The properties of the Higgs are not yet precisely measured.
- ▶ Many beyond the Standard Model theories predict invisible Higgs decays:
 - SUSY, extra dimensions, dark matter, etc.

How do you see something invisible?

- ▶ Invisible particles still carry energy and momentum.
- ▶ Sometimes the Higgs is produced with other particles:
 - this is called associated production
- ▶ These other particles are used to infer the presence of a Higgs.
- ▶ The visible momentum is then summed and compared to the known total to infer the presence of invisible particles (mE_T).

Production channels



Searches in the VBF channel

- ▶ VBF production has a distinctive topology and a high rate relative to ZH, making it the most promising channel:
 - The CMS expected limit on invisible branching fraction (BF(inv)) from VBF is 49% compared to 83% from ZH.

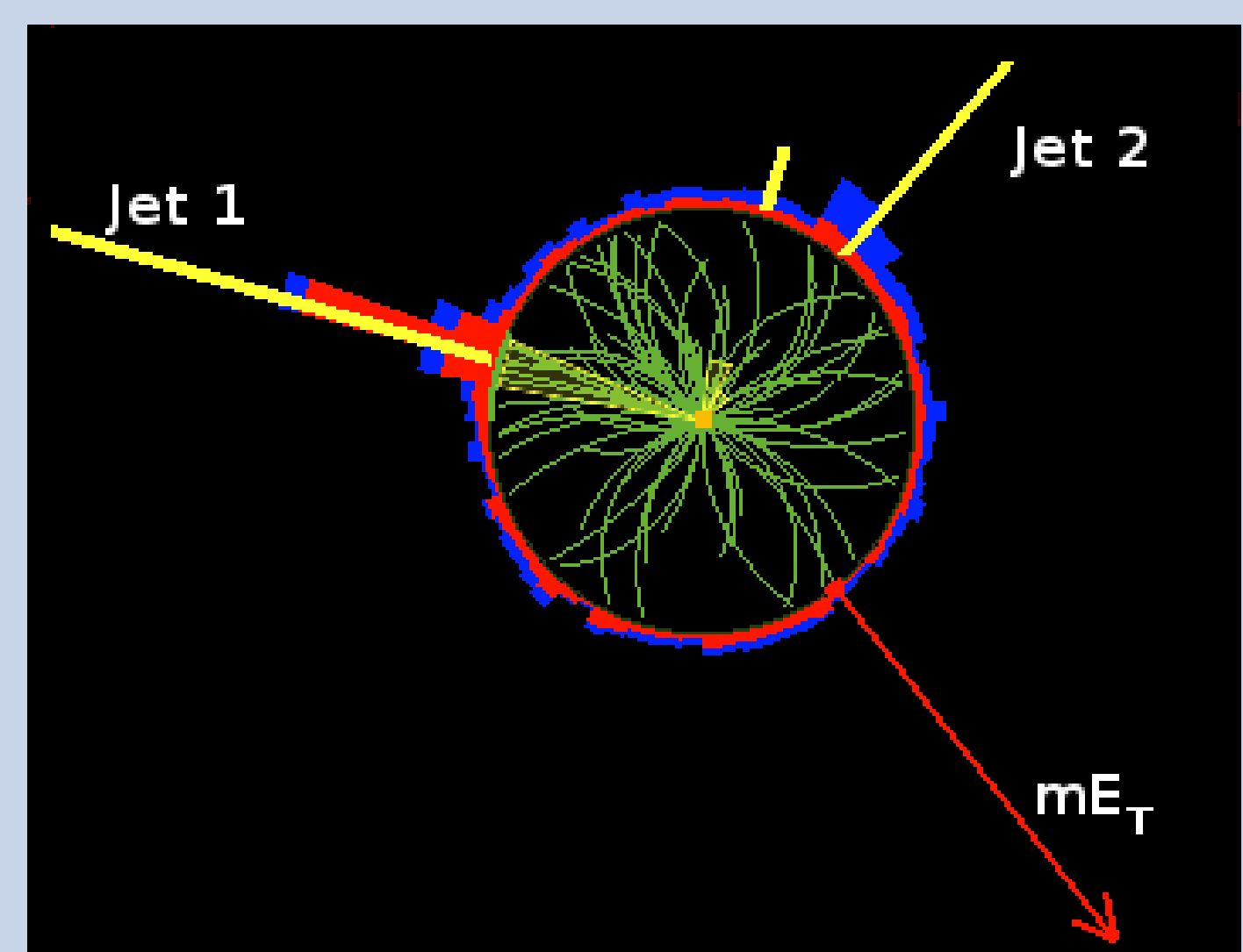
Strategy

- ▶ Perform a simple counting experiment.
- ▶ Select distinctive VBF topology:
 - 2 jets with a large polar angle separation,
 - veto events with any other particles present.
- ▶ Require missing momentum to select the invisible final state.
- ▶ Use hard cuts to restrict backgrounds.
- ▶ Estimate remaining backgrounds.

Background estimation

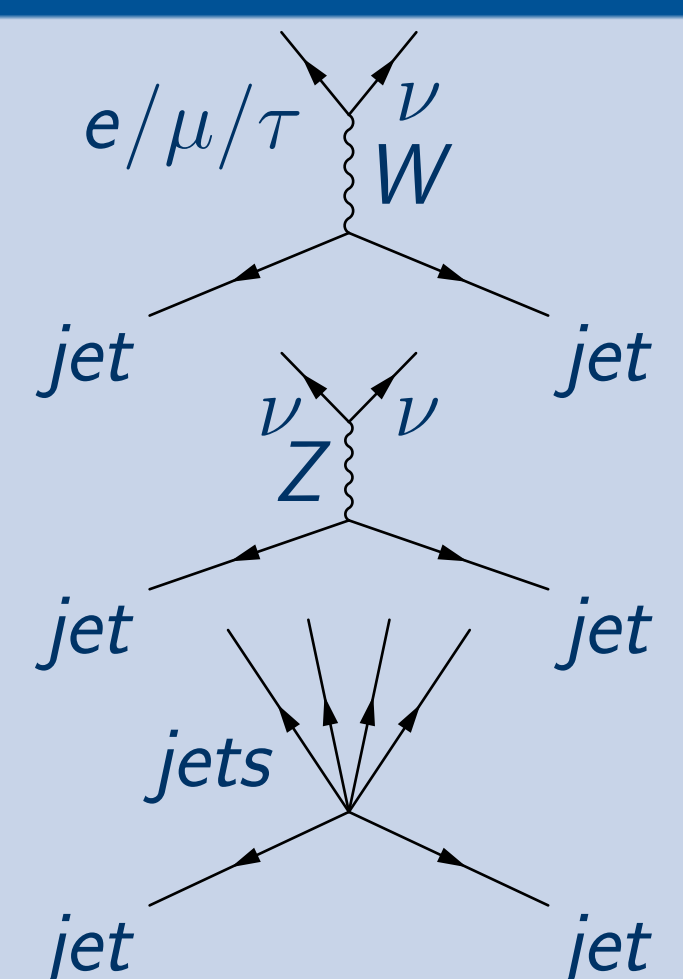
- ▶ We use a data driven method:
 - A control region enriched in background events is chosen,
 - The ratio between the signal and control regions from simulation is used to extrapolate to the signal region:

$$N_{Bkg}^{signal} = (N_{obs}^{control} - N_{otherbkg}^{control}) \cdot \frac{N_{Sim}^{signal}}{N_{Sim}^{control}}$$



Main backgrounds

- ▶ $W + \text{jets}$:
 - reduced by additional particle veto.
- ▶ $Z \rightarrow \nu\nu + \text{jets}$:
 - irreducible.
- ▶ QCD multijets:
 - reduced by cuts.



Results and future work

- ▶ 2 other searches are performed at CMS in the ZH channel.
- ▶ Combining all 3 searches gives a limit of 58% on invisible BF(inv) for a 125 GeV Higgs at 95% C.L.:
 - strongest limit on BF(inv) of the Higgs to date,
 - compatible with the standard model at the 2σ level.
- ▶ We have additional 'parked' data with lower trigger thresholds that is yet to be analysed and more data will be taken starting in 2015:
 - this should give more events in our control regions and thus reduce the errors on our background estimation.
- ▶ More information can be found in arXiv:1404.1344.

