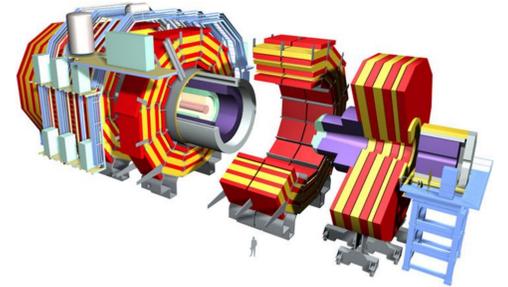


CMS $H \rightarrow \tau\tau$ background estimation with the Fake Factor Method

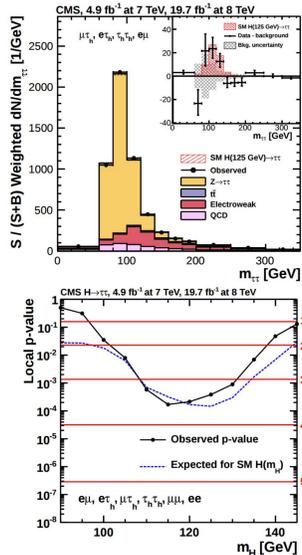
on behalf of the CMS collaboration

Johannes Brandstetter*, Martin Flechl, Markus Spanring*



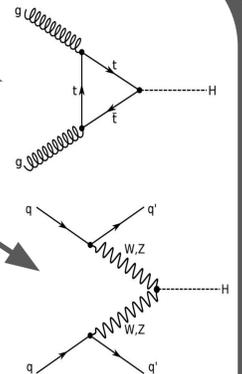
$H \rightarrow \tau\tau$

First evidence for a Higgs boson decay to a pair of tau leptons was found using events recorded with CMS in 2011 and 2012. The dataset corresponds to an integrated luminosity of 4.9 fb^{-1} at 7 TeV and 19.7 fb^{-1} at 8 TeV. An excess over the expected background contribution was observed with a significance of more than 3 standard deviations.



Overview

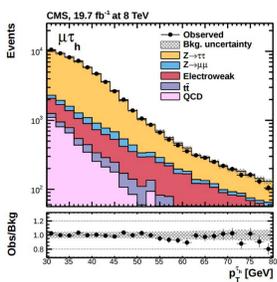
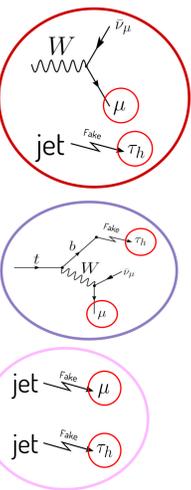
- The dominant production mode at the LHC is via gluon gluon fusion.
- The second-most-common production mode is vector boson fusion, which has a distinct signature of two well separated jets.
- The tau leptons originating from the Higgs boson decay can either decay leptonically or hadronically which leads to 6 final states.
 - ◆ $\mu\tau, e\tau, \tau\tau, ee, \mu\mu, e\mu$
- $H \rightarrow \tau\tau$ is the most sensitive decay mode to measure fermion Yukawa couplings due to the manageable backgrounds and sizeable branching ratio.



Motivation for Fake Factor

- The dominant backgrounds contain either a true tau lepton or a jet which fakes a tau lepton.
- The goal of the fake factor method is to estimate backgrounds with fake tau leptons without relying on simulation.

Example: $\mu\tau$

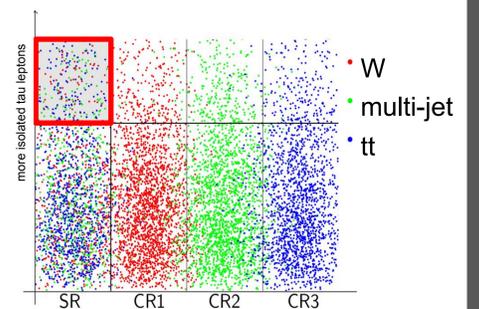


Basic Idea

- The ratio of isolated tau leptons to anti-isolated tau leptons ("fake factor") is calculated in a control region for each background.

$$FF = \frac{N_{\tau_{isolated}}}{N_{\tau_{anti-isolated}}}$$

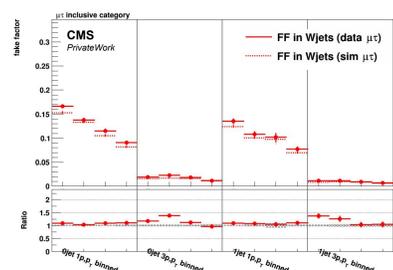
- To estimate the events in the signal region, the total number of events with anti-isolated taus n_{ASR} is counted and weighted with FF.



Fake Factors

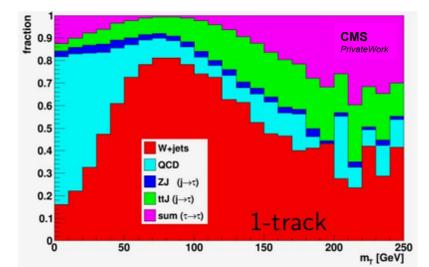
- The fake factor derived is not a global value but depends on several different parameters. Some of these are:

- ◆ Type of background (jet composition)
- ◆ Jet multiplicity
- ◆ Transverse momentum of the jet
- ◆ Number of charged particles in the jet



Template Fit

- To calculate the fractions of the different backgrounds in the anti-isolated region a template fit is performed.
- As templates the shapes are estimated either via simulation or data-driven methods.



Results

By combining the fraction derived via the template, the fake factors and the total number of anti-isolated events in the signal region it is possible to estimate the backgrounds containing a fake tau lepton.

$$1 = n_{ASR} \sum_{i \in BG} FF_i \cdot w_i$$

