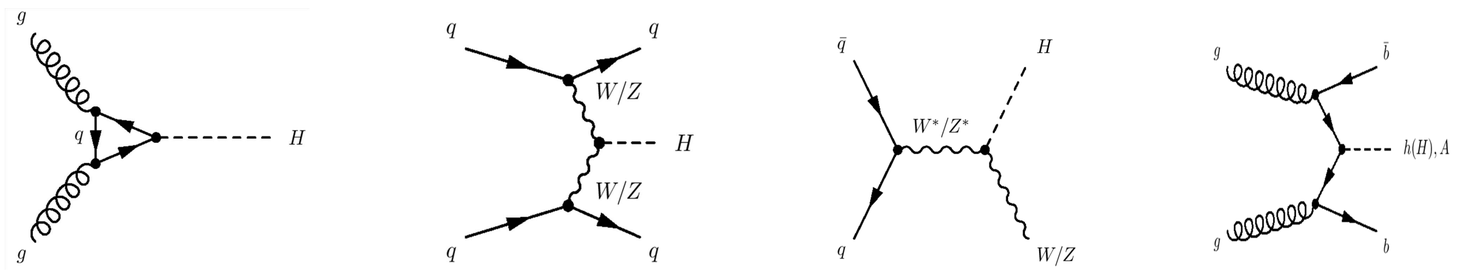
Higgs Boson searches in the H→ττ channel

In the Standard Model (SM) the electroweak symmetry breaking is achieved by introducing a complex scalar doublet leading to the prediction of the Higgs boson. Precision electroweak measurements constrain the SM Higgs mass $m_H < 158$ GeV. For such a light Higgs boson the branching ratio into τ leptons is between 8% and 1.8%, making the H→ττ decay mode channel very promising. In addition the measurement of the H→ττ decay rate provides a test of the SM prediction for the τ Yukawa coupling. In the Minimal Supersymmetric Standard Model (MSSM) the Higgs decay into τ pairs is also enhanced.

The analysis presented here corresponds to 2011(7 TeV) and 2012(8 TeV) data, with total L=10 fb^{-1}

Higgs production:



H→ττ decay channels

$\mu\tau_h$	τ-leptons into μ and hadrons (τ_h)
$e\tau_h$	τ-leptons into e and hadrons (τ_h)
eμ	τ-leptons into e and μ
μμ	both τ-leptons into μ

Event selection

Common requirements for all channels are the presence of at least one good primary vertex in the event and opposite charge of the leptons. The events are selected by applying cuts on kinematic variables such as p_T, η, E_T and $\Delta\phi$ depending on the decay channel.

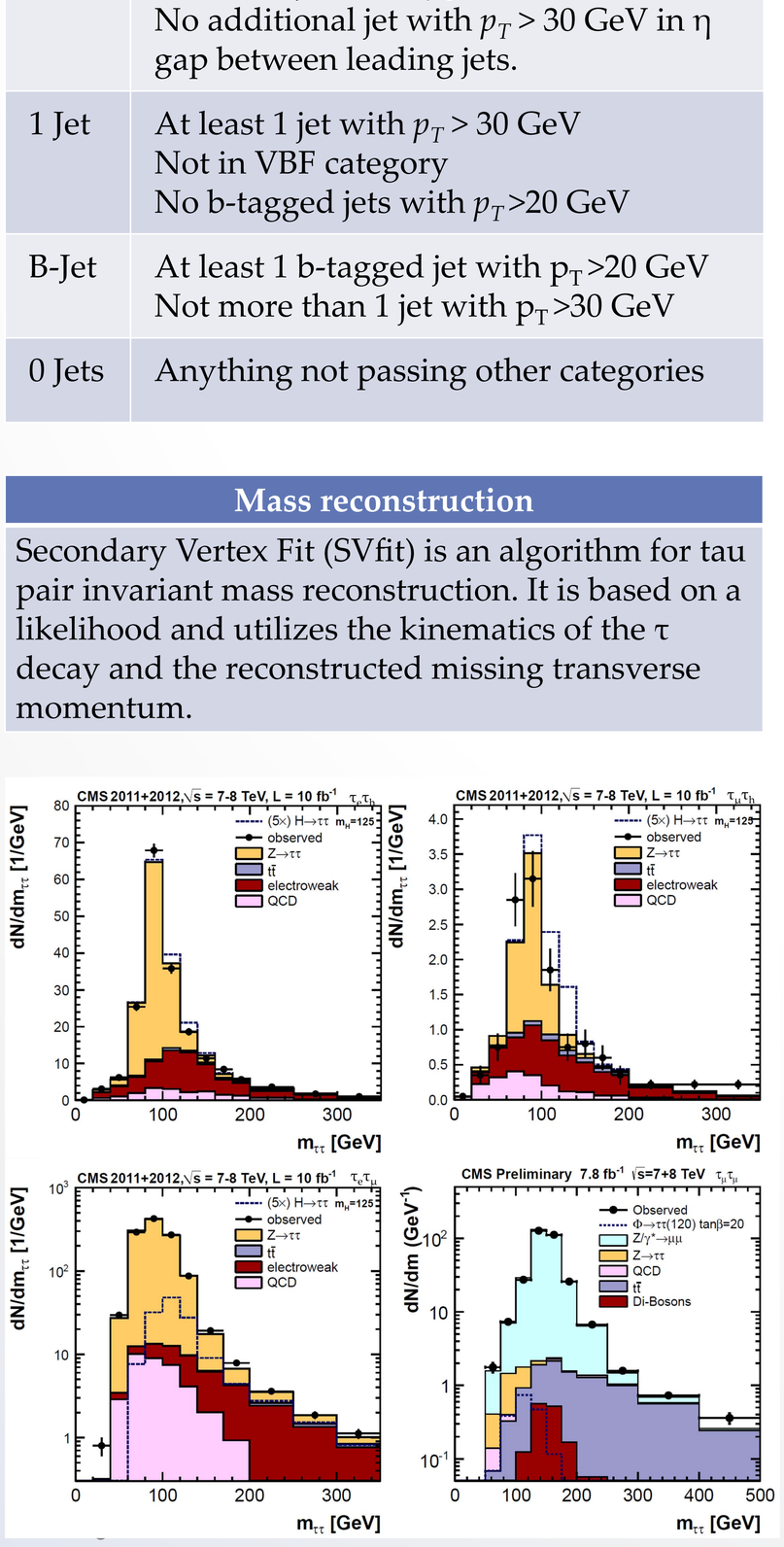
Event categories

To exploit the main processes for the production of Higgs bosons and to further suppress SM background processes, the events are classified into categories.

VBF	At least 2 jets with $p_T > 30$ GeV No additional jet with $p_T > 30$ GeV in η gap between leading jets.
1 Jet	At least 1 jet with $p_T > 30$ GeV Not in VBF category No b-tagged jets with p_T>20 GeV
B-Jet	At least 1 b-tagged jet with p_T>20 GeV Not more than 1 jet with p_T>30 GeV
0 Jets	Anything not passing other categories

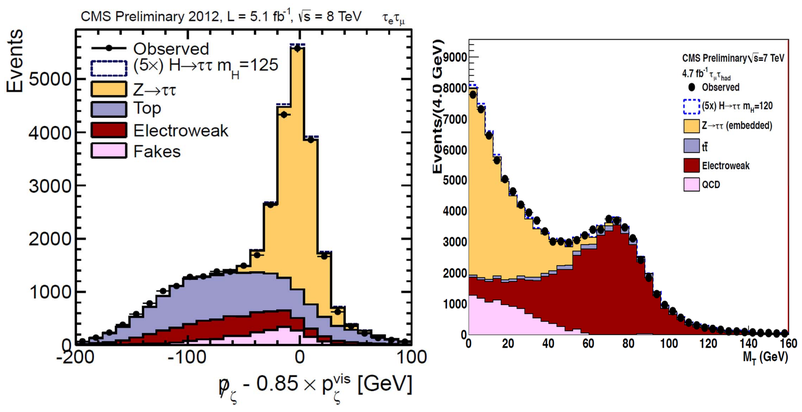
Mass reconstruction

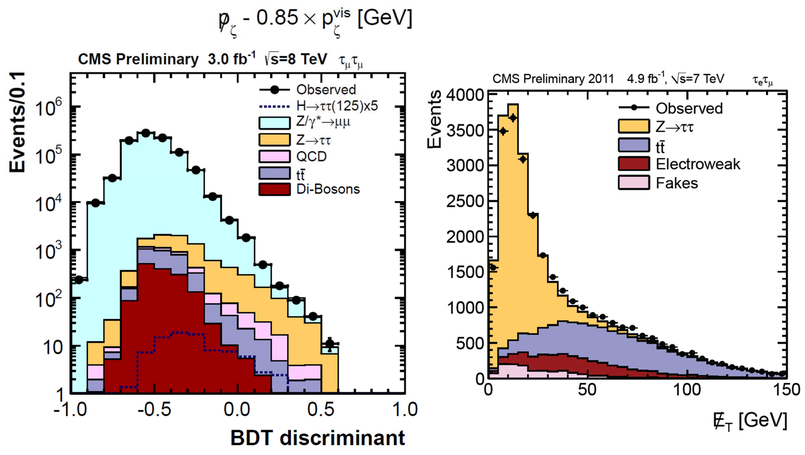
Secondary Vertex Fit (SVfit) is an algorithm for tau pair invariant mass reconstruction. It is based on a likelihood and utilizes the kinematics of the τ decay and the reconstructed missing transverse momentum.



Further selection

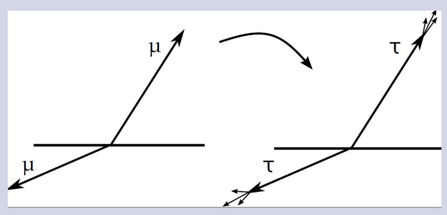
$\mu\tau_h$ $e\tau_h$ μe	In order to discriminate further against W+Jets or tt̄+Jets backgrounds a cut is applied to the reconstructed transverse mass: $m_T = \sqrt{2 \cdot p_T(l) \cdot MET(1 - cos(\Delta\varphi_l, MET))}$ or to the linear combination: $p^{cut}{}_\zeta(\alpha) = p^{miss}{}_\zeta - \alpha \cdot p^{vis}{}_\zeta$
μμ	To suppress Z→μμ events an MVA discriminator is used, constructed to distinguish H→ττ→μμ from Z/γ*→μμ and Z→ττ→μμ.





Z→ττ background

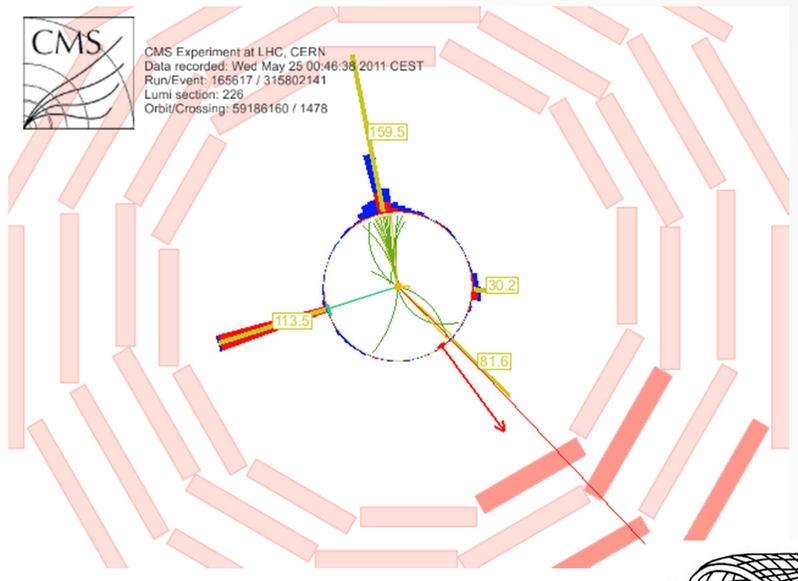
Z→ττ events are the most important irreducible background and their contribution is estimated from an embedded sample. This sample is derived from Z→μμ events in data where each muon has been replaced by a simulated τ lepton.



Other backgrounds

QCD	Shape and normalisation from same sign sample
tt̄+Jets	Normalisation from sideband
W+Jets	Normalisation from sideband
Z+Jets	MC corrected for fake rate
Special for the H→ττ→μμ channel	
DY→μμ	Shape from MC, normalisation from fit to sideband

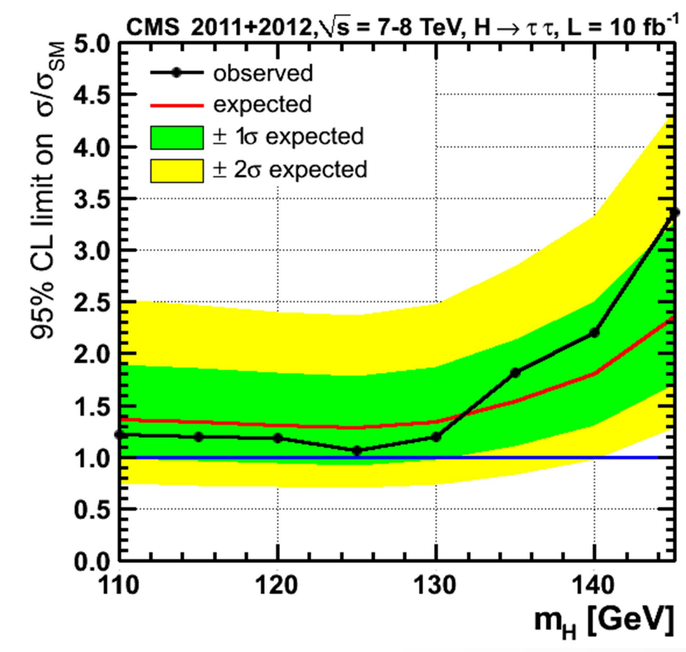
eμ VBF candidate event



Results

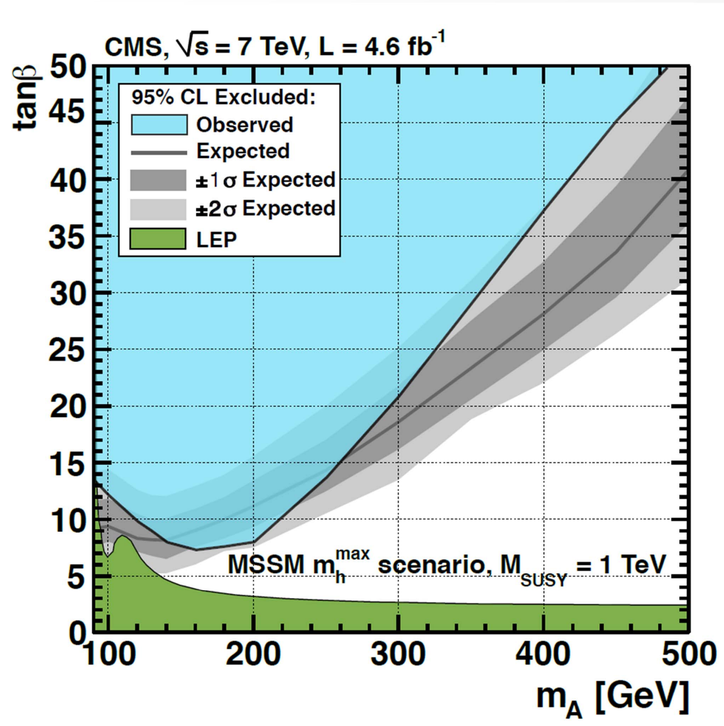
Standard Model

Neither the 7 TeV nor the 8 TeV analyses see an excess over the expected SM background, therefore exclusion limits are set.



Minimal SUSY Standard Model

The 95% CL exclusion limits are set on the parameter tanβ as a function of m_A the mass of the CP-odd neutral MSSM Higgs Boson.



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