PROCEEDINGS OF SCIENCE

Study of the H$\rightarrow \tau\tau$ decay channel from the ATLAS and the CMS Collaborations.

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The analysis strategy of the H$\rightarrow \tau\tau$ decay channel from the ATLAS and CMS Collaborations is presented. ATLAS has analyzed 17.6 fb^{-1} reporting a mild excess around 1.3 standard deviations. CMS has analyzed the full available data sample, 24.3 fb^{-1}, reporting an excess of about 2.9 standard deviations, with a measured μ value of 1.1$\pm$0.4 in good agreement with the Standard Model expectation. The differences between the analyses from the two collaborations have been discussed and the sensitivity projections for the future 14 TeV LHC run have been presented.

PoS(LHCPP2013)005

VI Italian workshop on p-p physics at the LHC,
8-10 May 2013
Acquario di Genova, Ponte Spinola, Area Porto Antico, Genova, Italy

1. Introduction

After the discovery of a new boson by the ATLAS and CMS Collaborations in July 2012 [1, 2], the quest for its properties has started. The data collected in 2011 and 2012 have been used to study the nature of the boson and make first measurements of its mass, spin and parity. In order to definitely state that this boson is the one predicted by the Higgs-Brout-Englert mechanism [3, 4], some evidence of its couplings to fermions was still required. A first evidence of this coupling was shown in 2013 conferences by the CMS collaboration, combining the results of the study of the decay channels with τ leptons and b-quark pairs, each one showing a significance larger than 2.

In these proceedings, the analysis of the τ lepton final state performed by the ATLAS and CMS Collaborations is presented, describing the differences between the strategies adopted by each team. The ATLAS and CMS summaries report searches for the Standard Model (SM) Higgs boson using final states with τ pairs in proton-proton collisions at $\sqrt{s} = 7$ and 8 TeV at the LHC. In total, CMS explores 5 independed final states, $\tau_e\tau_\mu$, $\tau_\mu\tau_\mu$, $\tau_e\tau_{\rm had}$, $\tau_\mu\tau_{\rm had}$, $\tau_{\rm had}\tau_{\rm had}$, while ATLAS in addition searches for the $\tau_e\tau_e$ decays as well. More information about the analysis strategies, the description of the reconstructed objects and used triggers can be found in Ref. [5, 7]. The main Higgs boson production mechanism at LHC is through the so called gluon fusion process ($gg \rightarrow$H+X), other sub-leading processes like Vector Boson Fusion ($qq\prime \xrightarrow{VBF} H\, qq\prime$) and associated production with a gauge boson ($qq \rightarrow$VH) [8, 9] are also considered in the analyses. While both collaborations consider hadronic decays from the gauge boson in the associated production [5, 6, 7], CMS has developed an independent analysis including also their leptonic decays. This analysis is not described in the present report but it is combined together with the other CMS analyses when presenting the final result. One of the most important ingredients that made this analysis possible is the capability to reconstruct and efficiently identify τ hadronic decays (often denoted as τ_h or $\tau_{\rm had}$). Both experiments have developed sophisticated techniques granting high efficiency (around 60% for τ visible transverse momentum around 20 GeV) and low fake rate from QCD jets (around 1% for jet transverse momentum around 20 GeV). The τ_h reconstruction in ATLAS makes use of reconstructed calorimeter clusters and tracks. All the information are fed into a Boosted Decision Tree (BDT) regression algorithm and the output is then used to discriminate between genuine τ_h leptons and QCD jets. CMS has adopted a completely different technique. The reconstructed particles from the Particle Flow algorithm are clustered into jets and then used to reconstruct possible tau decay modes: 1 prong, 1 prong with neutral pions and 3 prongs. The decay mode is mostly decided on the basis of the invariant mass between particles, trying to reconstruct either the ρ or the a^1 mass. All the other particles around those used to identify the decay mode are used in a Multi Variate Analysis (MVA) to compute the isolation value. Although the CMS and ATLAS performance in terms of efficiency and background rejection are very similar, the decay mode reconstruction allows CMS to control the τ energy scale uncertainty (through the τ_h invariant mass reconstruction) up to 3%, which is a much lower value than what was achieved in the ATLAS analysis.

This summary is organized as follows. The analysis strategies as well as the reconstruction and identification of hadronic tau decays are presented in section 2. The di-τ mass reconstruction is described in section 4 while the event categorization is discussed in section 5. Results are presented in section 6 and section 7 shows the projection of the sensitivity for the 14 TeV run.

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2. Analysis strategies

ATLAS analysis is using 17.6 fb^{-1} while CMS has analyzed the full available data sample, 24.3 fb^{-1}. The events have been selected at trigger level either by the presence of single isolated leptons with thresholds around 20 and 25 GeV (depending on the flavor) or by cross triggers which involve di-leptons or single leptons with the presence of an isolated jet. The full hadronic final state in CMS has the most complicated trigger requiring two isolated jets and a third central one; the request of the third jet is needed to reduce the input rate to the track reconstruction online. The request of a third jet does not limit the sensitivity of this channel because in order to suppress the huge QCD background a boosted Higgs configuration is anyway required. The signal events are characterized by true transverse missing energy (E_T^{miss}) due to the presence of the undectectable τ neutrinos. ATLAS applies a E_T^{miss} based selection (larger than 20 GeV) in all the channels, while CMS applies it only in the $e\tau_h$ one. The dominant backgrounds are represented by events with either genuine τ's (like Z→ $\tau\tau$) or with jets faking leptons (like W+jets and QCD di-jets events). The relative composition of the background depends on the decay channel. In order to suppress large cross section backgrounds topological selections are applied. The most important one is the cut on the reconstructed transverse mass between the electron (or muon) and the E_T^{miss}. This removes most of the W+jets contamination for the $\ell\tau_h$ channels. In order to extract the signal a fit to the di-τ invariant mass distribution is performed.

3. Missing Transverse Energy

In ATLAS, the E_T^{miss} reconstruction [10] uses calorimeter cells belonging to three-dimensional noise-suppressed clusters, calibrated according to the reconstructed and identified electrons, photons, hadronically decaying τ-leptons (τ_{h}), jets to which they are associated. The calorimeter information of cells associated to identified muons, is replaced by the muon trasverse momentum measured by the inner detector. Cells not associated with any such objects are also taken into account in the E_T^{miss} calculation. To mitigate the impact of pile-up on E_T^{miss} in the 8 TeV data, a pile-up suppression technique is being pursued based on the ratio of the sum of the transverse momentum of the tracks associated to the primary vertex and the sum of the transverse momentum of all the tracks in the event. The pile-up corrected E_T^{miss} resolution, for 20 reconstructed vertices, is twice smaller than the uncorrected E_T^{miss} resolution.

In CMS, the resolution of the E_T^{miss}, reconstructed as the opposite of the vectorial sum of the transverse momenta of all Particle Flow (PF) particles [11] , also degrades rapidly with the number of pile-up interactions. A multivariate regression is thus used to provide a more precise measurement of the E_T^{miss} in the presence of pile-up, the MVA PF E_T^{miss}. The regression is based on a BDT method taking as input the PF E_T^{miss} itself, as well as different flavours of the E_T^{miss} computed with charged and neutral particles stemming from the primary and pile-up vertices. For the average number of 19 primary vertices reconstructed in 2012, the resolution of the MVA PF E_T^{miss} is a factor of two better that the one obtained with the raw PF E_T^{miss}.

Figure 1 shows the resolution of the E_T^{miss} in ATLAS and CMS, as a function of the number of reconstructed primary vertices in the event.

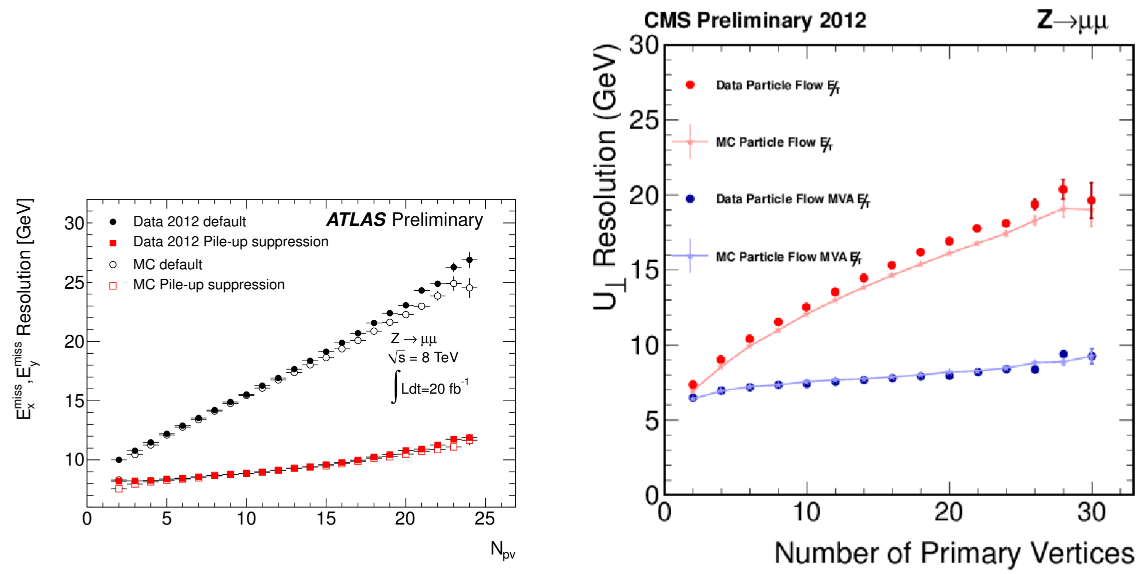

Figure 1: Resolution of x and y E_T^{miss} components in ATLAS (left) and the reconstructed recoil in Z boson projected on the axis perpendicular to the direction of the Z boson momentum ($U_\perp$) in CMS (right), as a function of the number of primary vertices for data and Monte Carlo simulation (MC) in $Z\to\mu\mu$ candidate events. The resolution after pile-up suppression is also shown [6, 7].

4. Di-tau mass reconstruction

The tau-pair invariant mass is the final discriminating observable used for searches both in ATLAS and CMS. In ATLAS the $\tau\tau$ mass is reconstructed by means of the Missing Mass Calculator (MMC) [12], except for 7 TeV data in the $H\to\tau_{lep}+\tau_{lep}$ channel (where τ_{leo} indicates leptonic τ decays). This technique provides a reconstruction of event kinematics in the $\tau\tau$ final state with $>99\%$ efficiency and between 13 and 20% mass resolution, depending on the event topology and final state (better resolution is obtained for events with boosted Higgs). Conceptually, the MMC is a more sophisticated version of the simple collinear approximation [13]. The latter method has the disadvantage of providing unphysical solutions for about 1/5 of the events, in particular when the E_T^{miss} and the parent boson p_T are small. The main improvement in MMC comes from requiring that relative orientations of the neutrinos and other decay products are consistent with the mass and kinematics of a τ lepton decay. This is achieved by maximising a probability defined in the kinematically allowed phase space region. In the $H\to\tau_{lep}+\tau_{lep}$ analysis at 7 TeV, the collinear approximation was used to reconstruct the mass of the $\tau\tau$ system in all categories with at least one jet. For $\tau_{lep}\tau_{lep}$ events with no jets, the invariant mass of the di-lepton and E_T^{miss} system, referred to as effective mass $m_{\tau\tau}^{\rm eff}$, was used because the performance of the collinear approximation is not optimal in events where τ-decay products are back-to-back in the transverse plane. To reconstruct $m_{\tau\tau}$ with improved resolution and higher efficiency to find a physical solution, a similar technique to the MMC exists in CMS; the SVFit algorithm [7]. The $m_{\tau\tau}$ resolution achieved by the SVFit algorithm is estimated to be 20% from simulation. Overall, the SVFit mass reconstruction allows for a better separation between signal and background than reconstructed $\tau\tau$ using the visible τ decay products only. Distributions of the reconstructed $m_{\tau\tau}$ are shown in Figure 2.

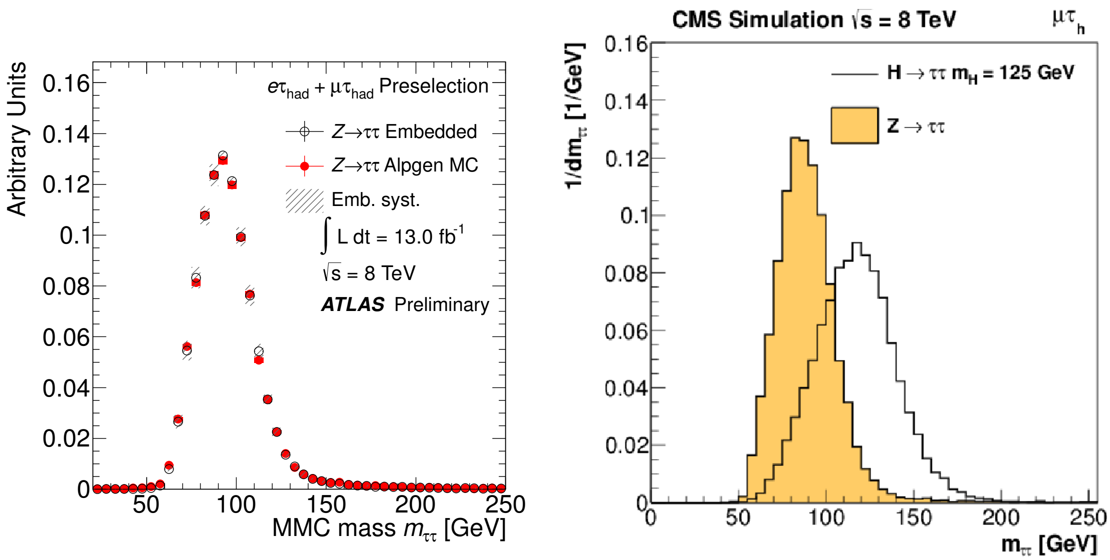

Figure 2: **Left:** MMC $\tau\tau$ mass distributions for the τ-embedded $Z \rightarrow \mu\mu$ data and simulated $Z \rightarrow \tau\tau$ events in the $\tau_{lep}\tau_{had}$ channel. **Right:** Normalized distribution of the SVFit$\tau\tau$ mass obtained from MC simulation in the $\mu\tau_h$ channel for the $Z \rightarrow \tau\tau$ background (solid histogram) and a SM Higgs boson signal of mass $m_H = 125$ GeV (open histogram) [6, 7].

5. Event categorization

Even after the application of topological selections it is not possible to extract any meaningful signal from the inclusive di-τ invariant mass distribution, due to the very low signal purity. In order to increase the signal over background ratio, events have been categorized in terms of the number of jets with transverse momentum above a given threshold, which depends on the experiment and the final state considered:

- 0-jet: very similar to the inclusive category. CMS does not fit any signal in this category, it is used only to constraint some experimental uncertainties.
- 1-jet: Depending on extra selection applied on events with at least 1 jet, and depending on the final state, the category is further divided into:
  - VH (only for ATLAS)
  - boosted Higgs
  - no boosted Higgs (only CMS)
- 2-jets: this category is supposed to select mostly events from VBF production mechanism. There is still some contribution from gluon fusion and the cuts may be tightened in the future. ATLAS also makes a further category to select VH$\rightarrow$qq+$\tau\tau$ events.
  - VH (only for ATLAS)
  - VBF: the selections in the VBF jets are similar but not identical. They require the presence of two jets with transverse momentum above 30 GeV and with quite large

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invariant mass. A selection on the difference in pseudo rapidity of the two jets is also required as well as the veto on any jet activity between the two.

Different categories are applied in different final states. As an example in the $\tau_h\tau_h$ final state only the VBF and the boosted Higgs categories are used. While ATLAS is applying special categories to select VH production mechanisms, CMS is applying a further categorization on the τ_h transverse momentum in the $\ell\tau_h$ final states (between 20 and 40 GeV and above 40 GeV).

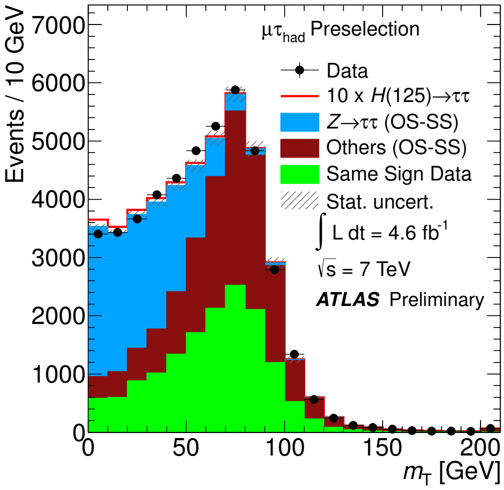
5.1 Background estimation

The largest source of background is the Drell-Yan production of $Z\to\tau\tau$, which is modelled using an embedding procedure. In a sample of selected $Z\to\mu\mu$ data events, the muon tracks and associated calorimeter cells are replaced by τ leptons from a simulated $Z\to\tau\tau$ decay with the same kinematics. These simulated τ decays are then merged with the initial data event. Therefore, only the τ decays and the corresponding detector response are taken from the simulation, whereas jets, underlying event and all other event properties including pile-up effects are obtained directly from the data. Modeling of the major background by means of embedded $Z\to\tau\tau$ events has the following advantage: a data-driven description of the entire event, except for τ-lepton decays, leading to significantly reduced systematic uncertainties compared to what can be achieved with the fully simulated samples. The Drell-Yan production of $Z\to\ell\ell$, where ℓ denotes the e or μ lepton, is an important source of background in the $\ell\ell$ and $\ell\tau_{\mathrm{had}}$ channel, due to the fact that the reconstructed $m_{\tau\tau}$ distribution peaks in the Higgs boson mass search range. In particular, this background source is important for the $\tau_e\tau_{\mathrm{had}}$ final state owing to the non-negligible probability for electrons to be misidentified as τ_{had}, The contribution of this background in the $\ell\tau_{\mathrm{had}}$ channels is estimated by Monte Carlo simulation using correction factors obtained by comparing simulation to data. The fake lepton background consists of events that have a reconstructed lepton that did not originate from the decay of a τ lepton or the leptonic decay of a W or Z boson. The normalisation and shape of relevant distributions are obtained from data with control regions in which the lepton isolation requirement is reversed. The background from W+jets production contributes significantly to the $\tau_e\tau_{\mathrm{had}}$ and $\tau_\mu\tau_{\mathrm{had}}$ channels when the W decays leptonically and one jet is misidentified as a τ_{had}. The background is modelled for these channels using simulated samples but the yield is normalized to data using control regions requiring a high cut on the trasnverse mass, m_T [1]. Figure 3 shows the predicted and observed m_T distribution obtained in the $\tau_\mu\tau_{\mathrm{had}}$ channel after the preselection criteria.

QCD multi-jet events, in which one jet is misidentified as a τ_{had} and another as a lepton (e or μ), constitute another important source of background in the $\tau_e\tau_{\mathrm{had}}$ and $\tau_\mu\tau_{\mathrm{had}}$ channels. The background estimation is entirely based on observed data using control samples where the lepton and the τ_{had} are required to have the same electric charge (SS). The expected contribution of the QCD multi-jet background is then rescaled by corrections derived from a QCD multi-jet enriched region in data, that account for potential differences in jet$\to\ell$ and jet$\to\tau_{\mathrm{had}}$ fake rates introduced by the same or opposite sign charge requirements.

The large QCD multi-jet production is also one of the dominant backgrounds in the $\tau_{\mathrm{had}}\tau_{\mathrm{had}}$ channel and data-driven methods are used to estimate its shape and normalization. In CMS, the

[1] Transverse mass $m_T = \sqrt{2p_T^\ell E_T^{\mathrm{miss}}(1-\cos\Delta\phi_{\ell,E_T^{\mathrm{miss}}})}$



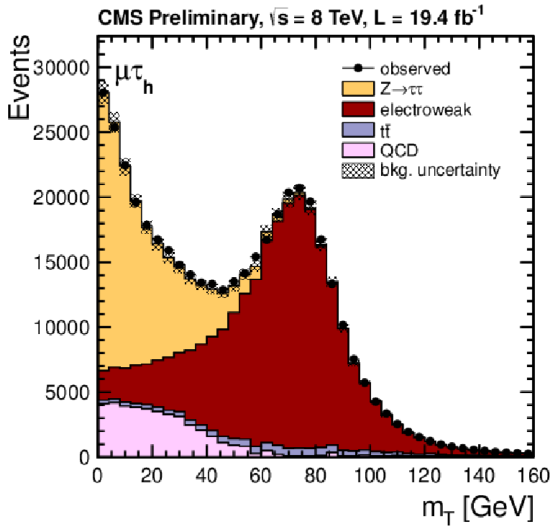


Figure 3: Transverse mass (m_T) in the $\tau_\mu \tau_{\rm had}$ channel after applying preselection cuts, in ATLAS (left) and CMS (right)[6, 7].

QCD background yield in the signal region is obtained by multiplying the yield in the opposite-sign (OS) relaxed isolation region by an extrapolation factor (loose-to-medium isolation), measured using the same signal control region. The QCD background shape in the signal region is taken from the relaxed τ_{had} isolation OS region, the effect of the relaxed isolation on the di-τ mass shape is controlled in the SS sample. In ATLAS, the QCD multi-jet mass shape is extracted from data samples with minimal true-τ contamination. In the 7 TeV dataset, the shape is obtained from data events in which all kinematic criteria are the same as those used to define the signal region, but the two $\tau_{\rm had}$ candidates do not have opposite charge (anti-opposite sign – notOS). In the 8 TeV dataset, the QCD multi-jet shape comes from OS data events in which the $\tau_{\rm had}$ identification criteria have been reversed compared to the signal region. This procedure has a clear advantage in modeling the low-mass tail of the $m_{\tau\tau}$ distribution. The QCD multi-jet normalization is obtained by performing a two-dimensional template fit to the track multiplicity distributions of the two $\tau_{\rm had}$ candidates. The tracks associated to the $\tau_{\rm had}$ candidates are counted in the cone defined by $\Delta R < 0.6$. The contribution from di-$\tau_{\rm had}$ events is a free parameter in the fit. The multi-jet template is modelled from a sample of SS candidates in the data. The $W \to \tau\nu +$jets accounts for a non-negliglible source of background events in the $\tau_{\rm had}\tau_{\rm had}$ channel. In such events, a jet is usually misedintified as a $\tau_{\rm had}$ candidate. This type of background events is estimated by simulation.

The predicted yield of the $t\bar{t}$ background process for all channels is obtained from simulation, with the yield rescaled to the one observed using a $t\bar{t}$-enriched control sample, extracted by requiring b-tagged jets.

Finally, the small background contribution in each channel from diboson and single-top production is estimated using the simulation.

5.2 Evaluation of the systematics uncertainties

In order to parametrize the signal and background uncertainties, several nuisance parameters

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are introduced in the fit to the mass shape. These nuisances can represent either the uncertainty on the total normalization of a background or (through morphing techniques) describe the uncertainty in the shape of the distribution. Theoretical uncertainties on the signal cross section are considered as well. The fit itself, through the background sidebands, can constraint these parameters and in some cases the uncertainty is greatly reduced with respect to what used in input. The most important systematics are those affecting the background normalization like he τ_h identification efficiency or the migration from one category to another due to the jet energy scale. Other kind of uncertainties are those related to the mass shape like the τ_h and E_T^{miss} energy scale. In some cases, when the number of events in the samples used to extract the mass shape is limited, bin-by-bin uncertainties are used, i.e. each bin in the template is let fluctuate independently from any other. This is the most conservative shape uncertainties to be applied. In general ATLAS, has larger uncertainties for what concerns the τ_h energy scale (as already stated the decay mode reconstruction used in CMS allows better constrains on the τ_h properties), while CMS has larger uncertainties for the τ_h identification, Z$\to\tau\tau$ normalization and the jet energy scale. Table 1 shows how some of the uncertainties affect the normalization of the backgrounds and signal samples in ATLAS and CMS. The ranges reflect the effect in the various categories and final states.

Table 1: Main systematic uncertainties entering the analyses [6, 7].

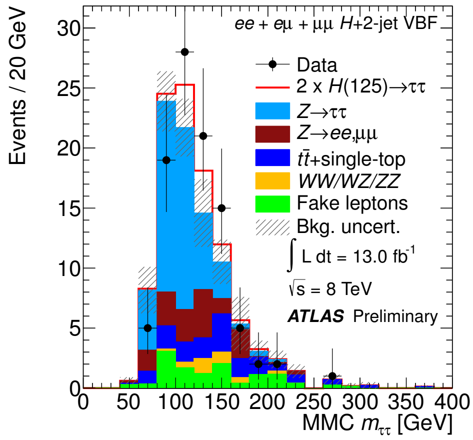
Experimental Uncertainties

Uncertainty	**ATLAS**	**CMS**
Tau ID & Trigger	$1-10\%$	$8-19\%$
Tau Energy Scale	$3-15\%$	3%
JES (Norm.)	$1-10\%$	$5-20\%$
$Z\to\tau\tau$ Category	$4-16\%$	$3-13\%$
Norm. QCD Multijet	$9-30\%$	$5-35\%$
Norm. W+jets	$10-33\%$	$10-30\%$
Signal cross section theoretical uncertainty	$8-28\%$	$10-30\%$

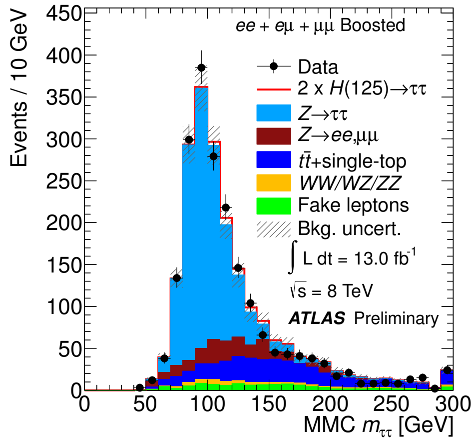
6. Results

In ATLAS, the most sensitive categories (channel-by-channel) are the Boosted, H+2-jet VBF and H+1-jet categories in the $\tau_{\rm lep}\tau_{\rm had}$ channel, and the H+2-jet VBF category for both the $\tau_{\rm lep}\tau_{\rm lep}$ and $\tau_{\rm had}\tau_{\rm had}$ channels. Distributions for the final discriminating variable $m_{\tau\tau}$ are shown in Figures 4(a)-4(f). No significant excess is observed in the data compared to the SM background-only expectation in any of the channels studied.

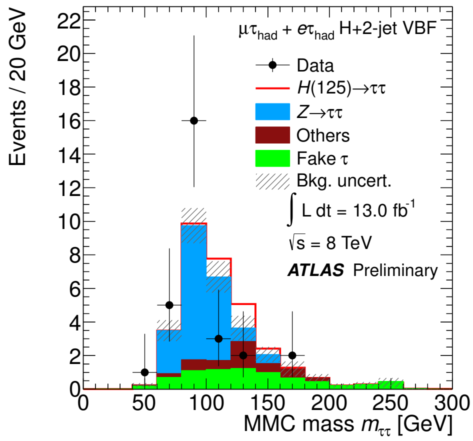
Figures 5(a)-5(e) show different $m_{\tau\tau}$ distributions obtained in the semi-leptonic, fully leptonic, and full hadronic channels in CMS. The most sensitive categories are the 1-jet/high-p_T and VBF. Figure 5(f) presents the combined observed and expected $m_{\tau\tau}$ distributions, weighting all distributions in each category of each channel by the ratio between the expected signal and background yields for this category in a $m_{\tau\tau}$ interval containing 68% of the signal. It also shows the differ-



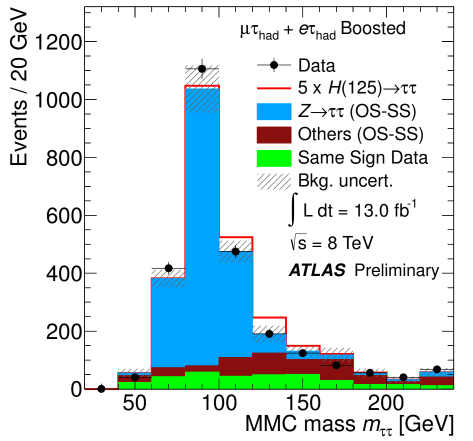
(a) $\tau_\ell\tau_\ell$ VBF category



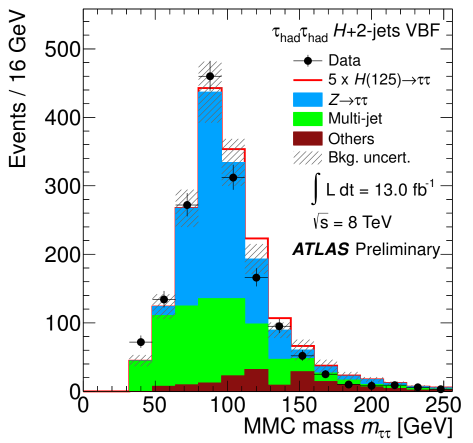
(b) $\tau_\ell\tau_\ell$ Boosted category



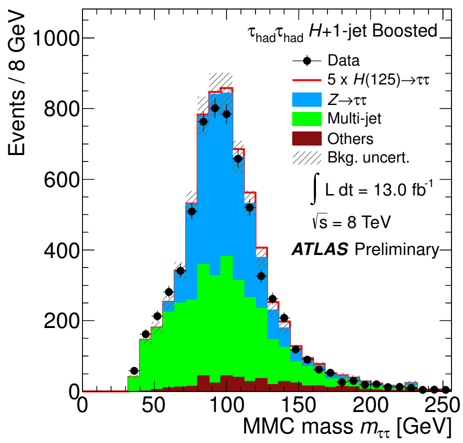
(c) $\tau_\ell\tau_{\mathrm{had}}$ VBF category



(d) $\tau_\ell\tau_{\mathrm{had}}$ Boosted category



(e) $\tau_\ell\tau_{\mathrm{had}}$ VBF category



(f) $\tau_{\mathrm{had}}\tau_{\mathrm{had}}$ Boosted category

Figure 4: Reconstructed $m_{\tau\tau}$ distributions of the selected events in the ATLAS analysis, for the 2-jet VBF and 1-jet Boosted categories [6].

ence between the observed data and expected background distributions, together with the expected distribution for a SM Higgs boson signal with $m_H = 125$ GeV.

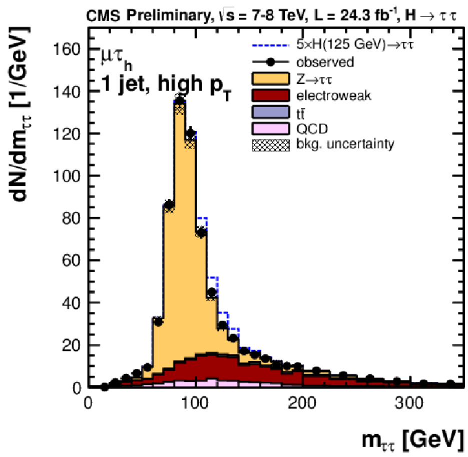
Both in ATLAS and CMS, the observed 95% Confidence Level (CL) upper limit is obtained using the modified frequentist construction CL$_s$ [14, 15].

Figure 6(a) shows expected and observed cross-section limits for the ATLAS combination of all three channels for 2011 and 2012 data as a function of the Higgs boson mass at the 95% confidence level. The combined expected limit varies between 1.2 and 3.4 times the predicted SM cross-section times branching ratio for the mass range between 100 and 150 GeV. The corresponding observed limits are in the range between 1.9 and 3.3 times the predicted SM cross-section times branching ratio for the same mass range. For $m_H = 125$ GeV specifically, the expected limit is 1.2 and the observed 1.9.

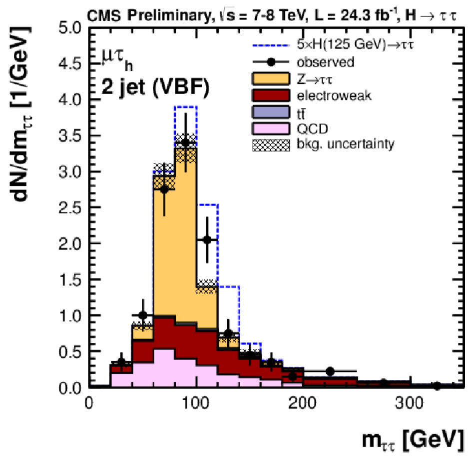
For the CMS analysis, the observed 95% CL upper limit together with the expectation in the background-only hypothesis is shown in Figure 6(b). An excess is visible in the observed limit. This excess is better quantified in Figure 7, which shows the significance for Higgs-boson mass hypotheses ranging from 110 to 145 GeV. These results include the search for a SM Higgs boson decaying into a τ pair and produced in association with a W or Z boson decaying leptonically. The maximum significance is observed at $m_H = 120$ GeV, corresponding to a significance of 2.93 standard deviations. For $m_H = 125.8$ GeV, the significance is 2.85 standard deviations.

7. Future projections

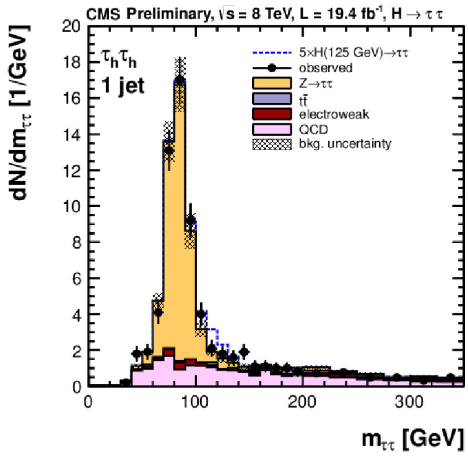
Both experiments are finalizing the analyses to achieve better sensitivity, final results are expected by the end of the 2013. ATLAS has recently reviewed the τ_h identification and will most likely add the associated production with gauge bosons decaying leptonically; CMS is optimizing the τ_h isolation and it is not planning to change much the event categorization. For what regards future 14 TeV analysis, some preliminary projections to 300 fb^{-1} show that in principle CMS would be able to measure the Higgs boson coupling to τ leptons with an uncertainty of about 10%. This estimate has been done extrapolating some 2012 results scaling the systematics uncertainties as $1/\sqrt{L}$ where L is the total integrated luminosity. Although there is some margin to improve further the analysis with 300 fb^{-1}, that's to say that the future 14 TeV running conditions will be somehow harder than what faced in the past. Even if the level of the pile-up will not be much different from 2012 data, due to the higher center of mass energy and instantaneous luminosity the trigger strategies will have to be revised. A simple extrapolation of the 2012 trigger menu to the 2015 running conditions (without changing hardware or thresholds) would lead to a total rate of about 2 kHz. This is at the moment not sustainable by any of the two experiments unless the number of computing nodes for offline reconstruction is increased adequately. It is becoming more and more important to start thinking about the future physics programme in order to properly share the bandwidth between analyses and set up trigger strategies that will allow an efficient collection of the interesting events. Most likely it will not be possible to collect events with inclusive selections and apply event categorization in offline only; both experiments will have to target, at least for some channels, specific production mechanisms already at trigger level, e.g. deploying VBF-like jet selections already at Level-1.



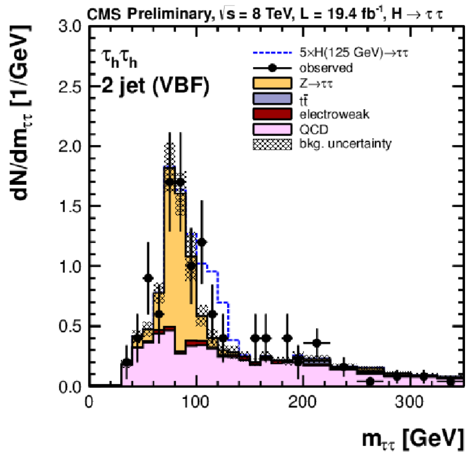
(a) $\tau_\mu \tau_{\rm had}$ 1-jet category



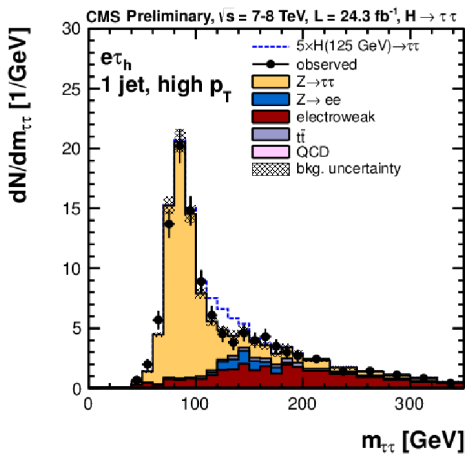
(b) $\tau_\mu \tau_{\rm had}$ VBF category



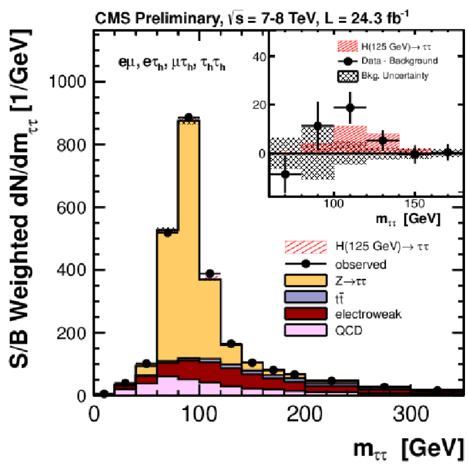
(c) $\tau_{\rm had} \tau_{\rm had}$ 1-jet category



(d) $\tau_{\rm had} \tau_{\rm had}$ VBF category

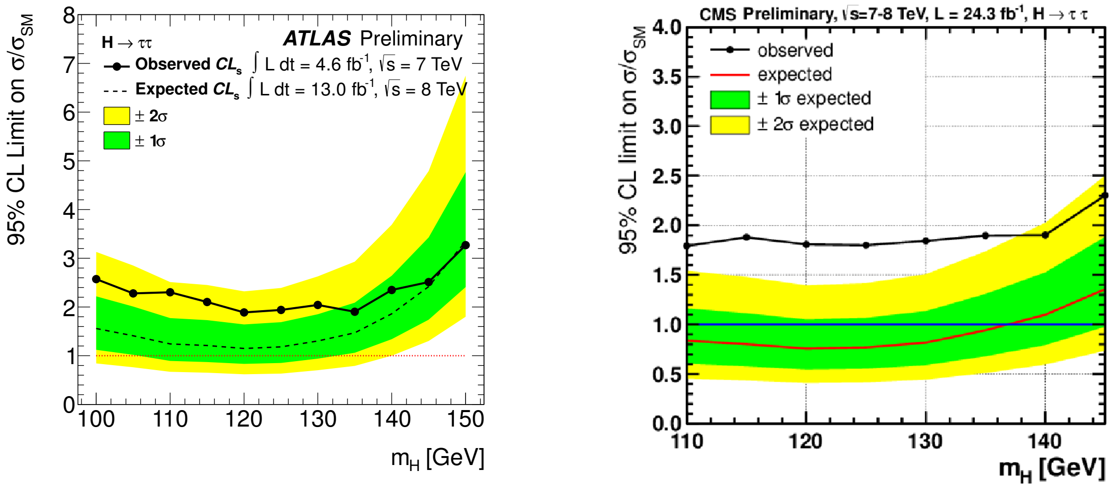


(e) $\tau_e \tau_{\rm had}$ 1-jet category



(f) $\tau\tau$ combined

Figure 5: Expected and observed reconstructed $m_{\tau\tau}$ distributions of the selected events in the CMS analysis, for the VBF and 1-jet categories. Combined observed and expected $m_{\tau\tau}$ distributions for all five channels is also shown. The insert shows the corresponding difference between the observed data and expected background distributions [7].



(a) ATLAS combined limits

(b) CMS combined limits

Figure 6: Combined observed 95% CL upper limit on the signal strength parameter $\hat{\mu} = \sigma/\sigma_{\rm SM}$, together with the expected limit obtained in the background hypothesis, as a function of the Higgs boson mass, m_H. The bands show the expected one- and two-standard-deviation probability intervals around the expected limit. CMS results include also the search for a SM Higgs boson decaying into a τ-pair and produced in association with a W or Z boson decaying leptonically [6, 7].

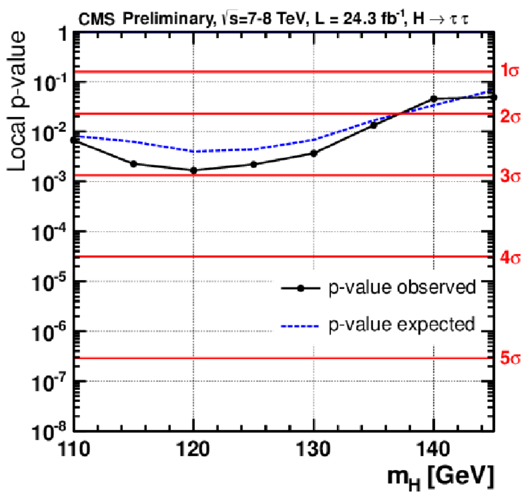


Figure 7: Observed and expected p-value $1-\mathrm{CL}_b$, and the corresponding significance in number of standard deviations in the CMS analysis. These results include the search for a SM Higgs boson decaying into a τ pair and produced in association with a W or Z boson decaying leptonically. An excess of events is observed over a broad mass range, with a maximum local significance of 2.93 standard deviations at $m_H = 120$ GeV [7].

8. Conclusions

ATLAS and CMS Collaborations have reported searches for the SM Higgs boson decaying into tau-lepton pairs [6, 7]. ATLAS has analyzed 17.6 fb^{-1} reporting a mild excess around 1.3 standard deviations, while CMS has analyzed the full available data sample, 24.3 fb^{-1} reporting a larger excess of about 2.9 standard deviations, with a measured μ value of 1.1±0.4 in good agreement with the SM expectation. Final results on the full data sample are expected by the end of the 2013 by both experiments.

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