IL NUOVO CIMENTO Vol. 36 C, N. 1 Gennaio-Febbraio 2013
DOI 10.1393/ncc/i2013-11467-8

Colloquia: IFAE 2012

Search for the Standard Model Higgs boson decaying to di-tau channel with fully hadronic mode in ATLAS experiment

Z. Zinonos
Università di Pisa - Pisa, Italy

ricevuto il 31 Agosto 2012

Summary. — A search for the Standard Model Higgs boson in the di-tau decay channel with fully hadronic tau decay is presented based on $4.7\,\text{fb}^{-1}$ of integrated luminosity recorded by the ATLAS detector in pp collisions from the LHC at $\sqrt{s} = 7\,\text{TeV}$. Upper limits at 95% CL on the SM production cross section were set and found to be about 6 times the SM Higgs boson production cross section in the most sensitive range of $110 \le m_H \le 135\,\text{GeV}$.

PACS 14.80.Bn – Standard-model Higgs bosons.
PACS 13.35.Dx – Decays of taus.
PACS 13.85.Rm – Limits on production of particles.

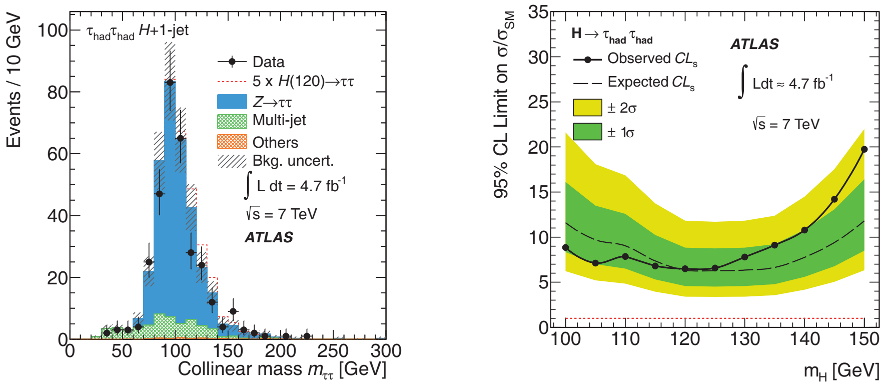
1. – Introduction

In the Higgs boson mass range 100–150 GeV, the $H \to \tau^+\tau^-$ decay mode has branching ratios between 8% and 1.8% and thus is a promising channel to be searched for at the LHC. The $H \to \tau^+\tau^-$ search is complementary to searches with other decays in the same mass range and enhances the overall sensitivity. In this work we search for the SM Higgs boson in the di-tau decay channel, where both tau leptons decay hadronically, on a data sample of $4.7\,\text{fb}^{-1}$ integrated luminosity collected by ATLAS in 2011 [1].

2. – Selection and reconstruction of physics objects

Jets are reconstructed using the anti-k_t algorithm [2] with a distance parameter value of $R = 0.4$, taking as input three-dimensional noise-suppressed clusters in the calorimeters. Reconstructed jets with $p_T > 20\,\text{GeV}$ and within $|\eta| < 4.5$ are selected. Events are discarded if a jet is associated with out-of-time activity or calorimeter noise.

The four-momentum of the τ_{had} candidates are reconstructed from the energy deposits in the calorimeters and the rejection of jets misidentified as hadronic τ decays is performed by a multivariate discriminator based on a boosted decision tree [3] that uses both tracking and calorimeter information. The identification is optimised to be 50% efficient while the jet misidentification probability is kept below 1%. A τ_{had} candidate must lie within $|\eta| < 2.5$, have a transverse momentum greater than 20 GeV, one or



(a) (b)

Fig. 1. – (a) Reconstructed $m_{\tau\tau}$ of the selected events in the $H \to \tau_{\rm had}\tau_{\rm had}$ channel. Expectations from the Higgs boson signal ($m_H = 120\,\text{GeV}$) and from backgrounds are given. (b) Observed (solid) and expected (dashed) 95% confidence level upper limits on the signal cross section times branching ratio for this channel, normalised to the SM expectation, as a function of the Higgs boson mass. Expected limits are given for the scenario with no signal. The bands around the dashed line indicate the expected statistical fluctuations of the limit.

three associated tracks (with $p_T > 1\,\text{GeV}$) and a total charge of ± 1 computed from the associated tracks. Dedicated electron and muon veto algorithms are used [4].

3. – Search category

Only a single H + 1-jet category is defined for the $\text{H} \to \tau^+_{\rm had}\tau^-_{\rm had}$. The collinear mass approximation is used for the Higgs mass reconstruction [4], with p_T fraction cuts $0 < x_1, x_2 < 1$. Events at this stage are used as a control sample to derive the normalisation of the $Z^*/\gamma \to \tau^+\tau^-$ background. Then, events are selected if the missing transverse energy ($E_T^{\rm miss}$) is greater than $20\,\text{GeV}$ and if the leading jet has a transverse momentum $p_T > 40\,\text{GeV}$. The two τ candidates are required to be separated by $\Delta R < 2.2$. Only events with an invariant mass of the di-tau pair and the leading jet $m_{\tau\tau j} > 225\,\text{GeV}$ are further considered.

4. – Results

No significant excess is observed in data compared to the SM expectation. Exclusion limits at the 95% confidence level, normalised to the SM cross section times the branching ratio of $H \to \tau^+\tau^-$ ($\sigma_{\rm SM}$), are set as a function of the Higgs boson mass. Figure 1(a) shows the reconstructed di-tau mass distribution for data and simulation. Figure 1(b) shows the expected and observed limits for the individual channels and for the combined result. The most sensitive range of this channel is found to bearound $m_H \sim 125\,\text{GeV}$.

REFERENCES

[1] ATLAS Collaboration, arXiv:1206.5971 [hep-ex].
[2] Cacciari M. *et al.*, *JHEP*, **04** (2008) 063; [arXiv:0802.1189 [hep-ph]].
[3] ATLAS Collaboration, ATLAS-CONF-2011-152, [http://cdsweb.cern.ch/record/1398195].
[4] ATLAS Collaboration, ATL-COM-PHYS-2012-051, https://cdsweb.cern.ch/record/1417492.