

Motivation

The observation of a charged Higgs boson would clearly indicate new physics beyond the Standard Model (SM). There are many non-minimal Higgs scenarios that predict the presence of a charged Higgs boson, like Two Higgs Doublet Models (2HDM). The Higgs sector of the Minimal Supersymmetric extension of the Standard Model (MSSM) belongs to the group of the type-II 2HDM.

Methods

Charged Higgs Search Channels:

Lepton+Jets: $t\bar{t} \rightarrow b\bar{b}WH^+ \rightarrow b\bar{b}(q\bar{q}')(\tau_{\text{lep}}\nu)$
 τ +Lepton: $t\bar{t} \rightarrow b\bar{b}WH^+ \rightarrow b\bar{b}(l\nu)(\tau_{\text{had}}\nu)$
 τ +Jets: $t\bar{t} \rightarrow b\bar{b}WH^+ \rightarrow b\bar{b}(q\bar{q}')(\tau_{\text{had}}\nu)$

Data-Driven Background Estimation Techniques [2]:

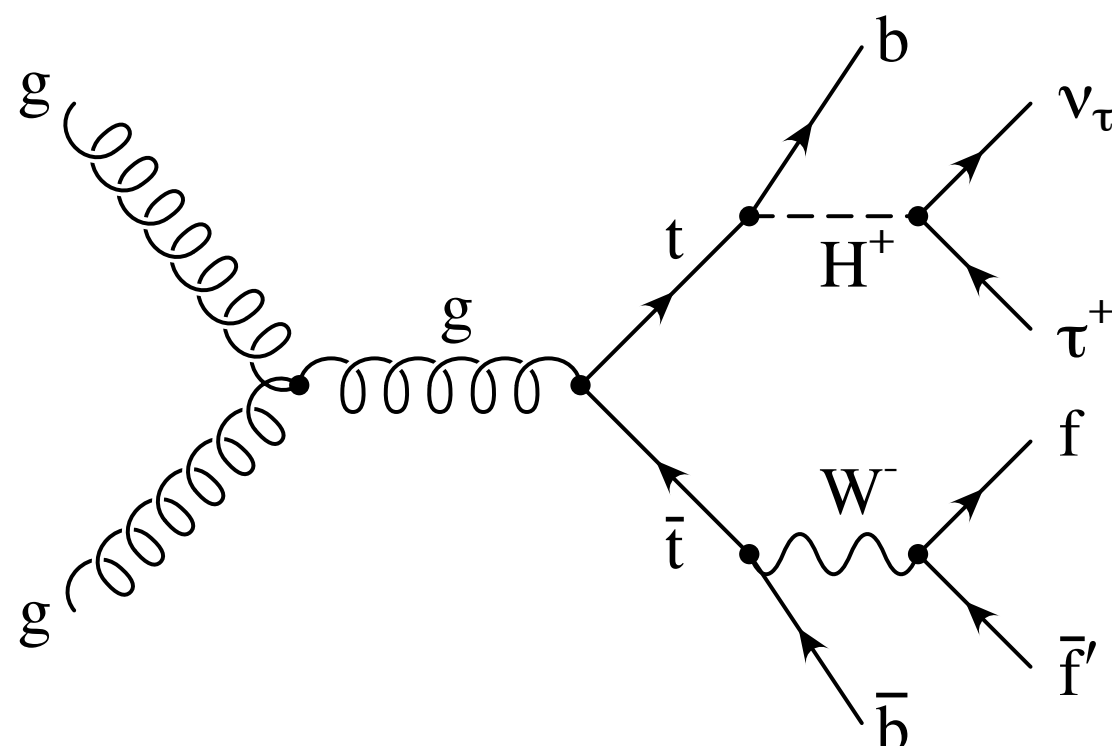
True Tau Background: Embedding Technique
 Fake Tau Background: Misidentification Rates Measured in Data
 Multi-Jet Background: Fit Sideband in Data with Template from Control-Region

Selection τ +Lepton Analysis:

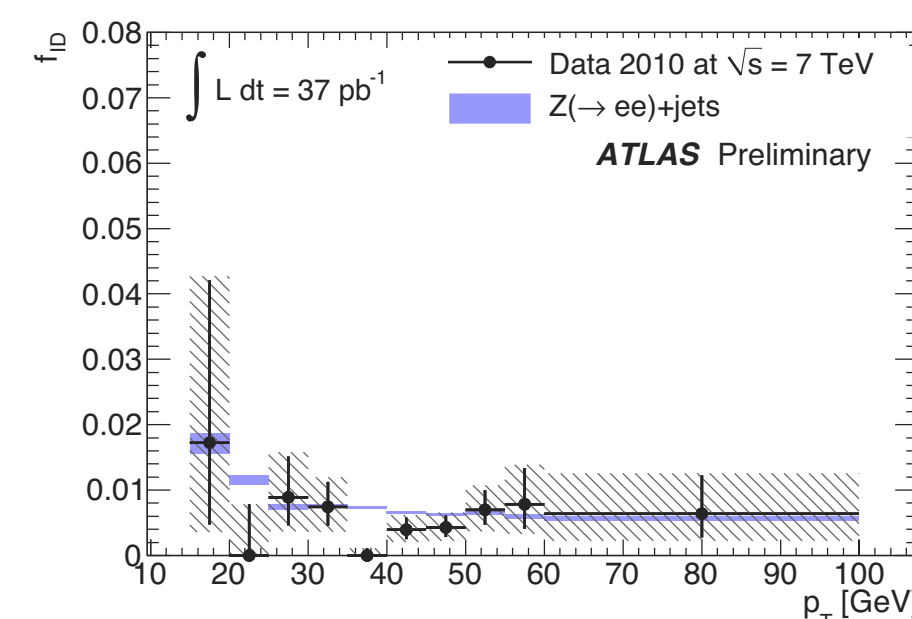
- exactly 1 lepton (μ/e), trigger-matched;
- exactly 1 τ_{had} lepton;
- > 2 jets, at least one b -jet;
- $\Sigma p_T > 100$ GeV.

Some Details

- So far ATLAS as well as CMS searched for the "light" charged Higgs boson, $m_{H^\pm} < m_t$.
- The largest source for light charged Higgs are top-quarks decaying into b -quarks and $H^\pm$.



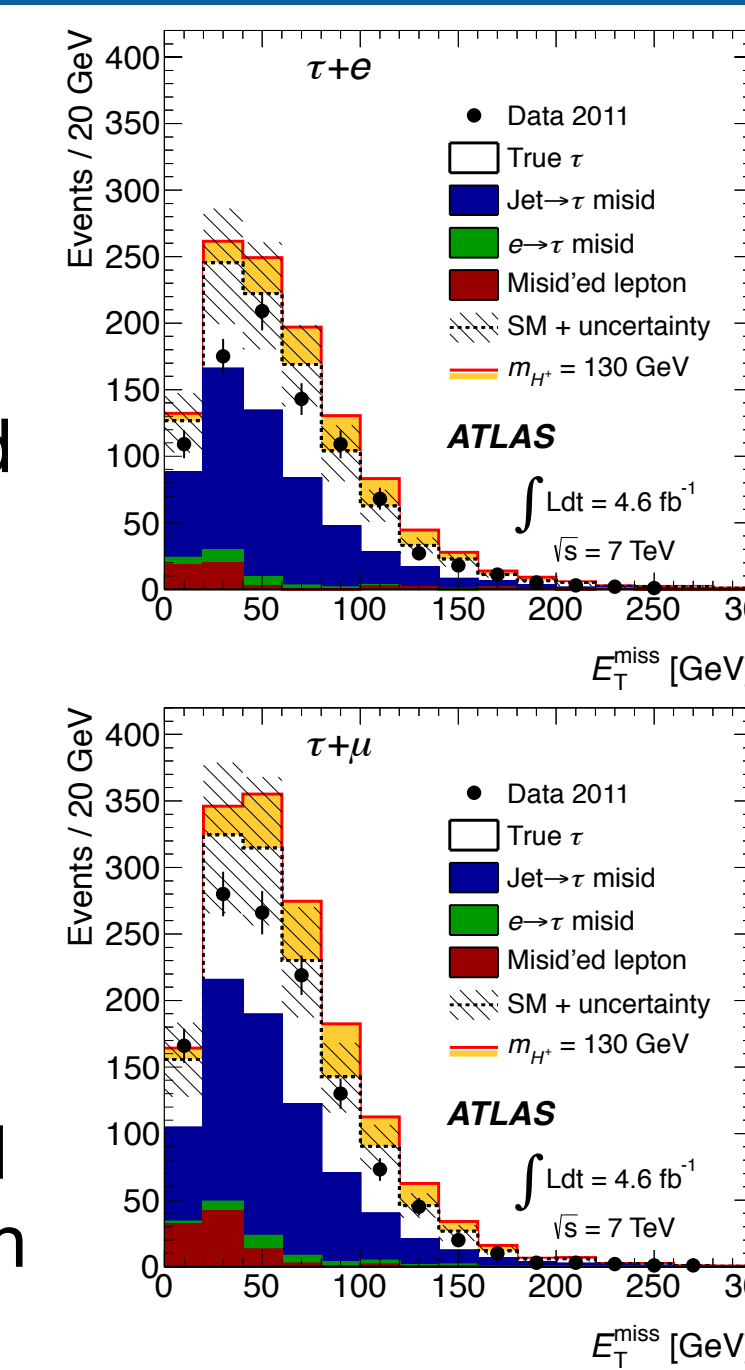
Background Estimation: Electron-Tau-Misidentification



- Measure the rate of electrons misidentified as τ_{had} in the data via Tag and Probe method of $Z \rightarrow ee$ events [1].
- Dedicated studies [2] showed: application legitimate in busy top-pair environment.

Trigger Studies: For the τ +Jets Channel

- Dedicated τ_{had} +MET trigger items were proposed and studied to ensure maximal signal efficiency along with stable rates throughout the 2012 data-taking [8,9].



New Idea: The Ratio Method

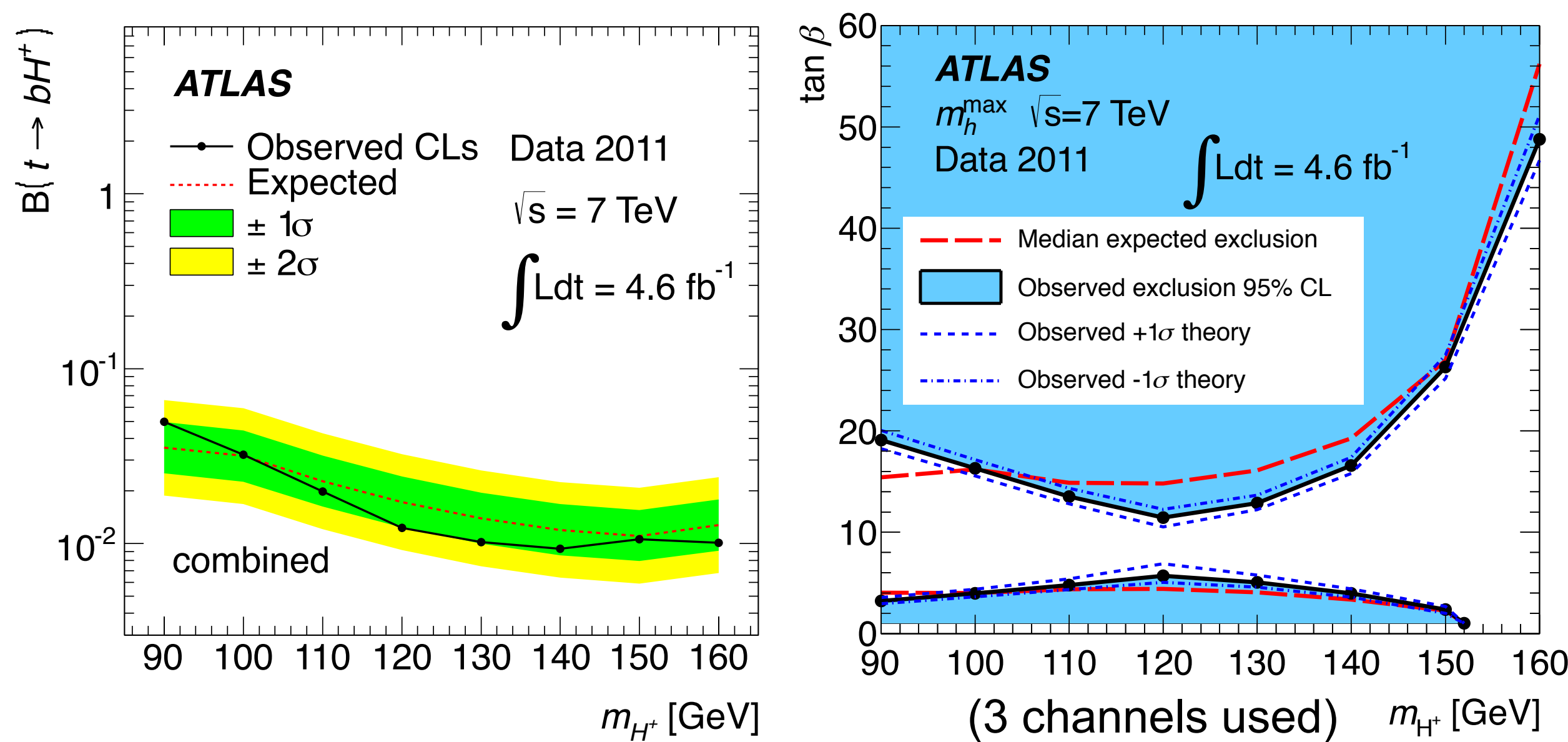
- Measure the ratio R_l of top-pairs decaying to τ_{had} & lepton (μ/e) and so-called dileptonic decays.
- Very sensitive to the charged Higgs, as in most models $H^\pm$ prefer a decay to τs if lighter than the top-quark.

$$R_l = \frac{\mathcal{B}(t\bar{t} \rightarrow b\bar{b} + l\tau_{\text{had}} + N\nu)}{\mathcal{B}(t\bar{t} \rightarrow b\bar{b} + ll' + N\nu)}$$

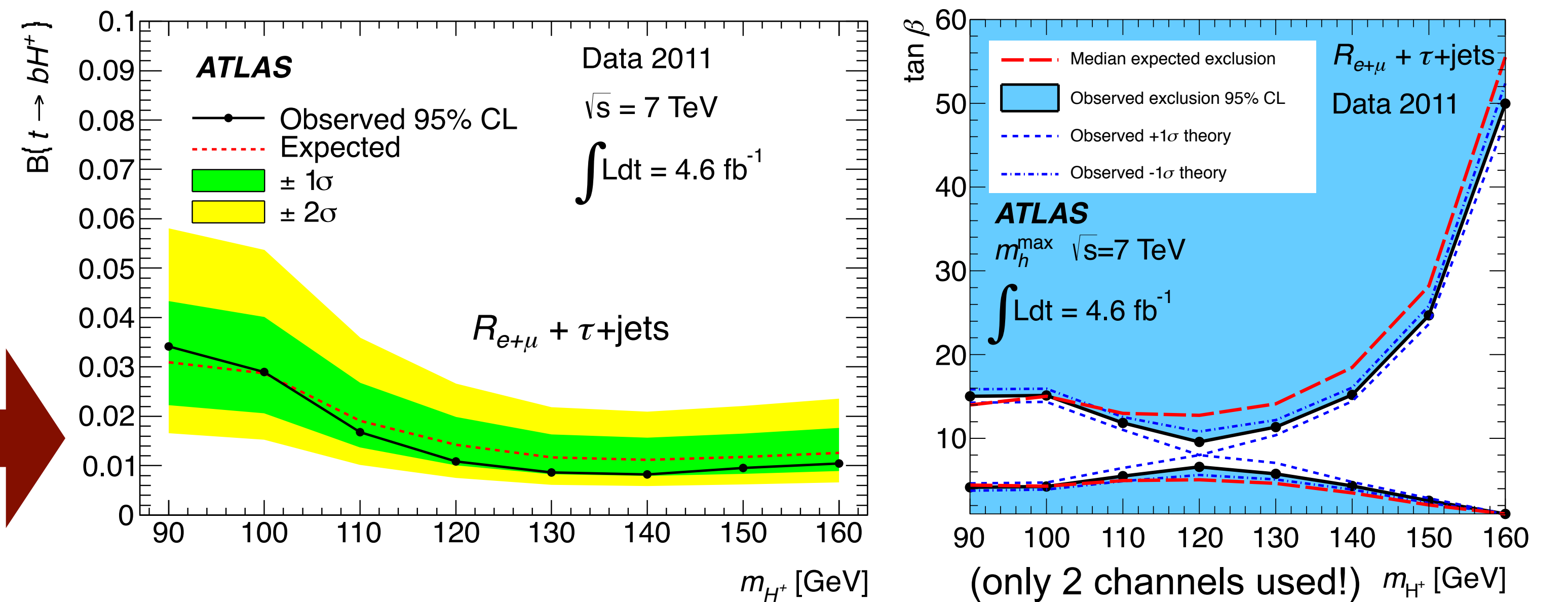
Almost all systematic uncertainties cancel, except those related to the τ_{had} decay and the lepton!

Recent Results

Branching Ratio Limits and Interpretation in the MSSM [7]:



Improvements with the Ratio-Method [12]:



Publications

- "Measurement of the Mis-identification Probability of Leptons from Hadronic Jets and from Electrons", The ATLAS Collaboration, ATLAS-CONF-2011-113.
- "Data-driven estimation of the background to charged Higgs boson searches using hadronically-decaying tau final states in ATLAS", The ATLAS Collaboration, ATLAS-CONF-2011-051.
- "Searches for Charged Higgs Bosons in ATLAS", Czodrowski, P., ATL-PHYS-SLIDE-2011-625.
- "Searches for Charged Higgs Bosons in ATLAS", Czodrowski, P., ATL-PHYS-PROC-2011-285, NCC Issue 3 (2012) pp. 213-216.
- "Search for Charged Higgs Bosons in the τ +jets Final State in $t\bar{t}$ Decays with 1.03 fb^{-1} of pp Collision Data Recorded at $\sqrt{s} = 7$ TeV with the ATLAS Experiment", The ATLAS Collaboration, ATLAS-CONF-2011-138.
- "Search for charged Higgs bosons decaying via $H^\pm \rightarrow \tau + \nu$ in $t\bar{t}$ events using 4.6 fb^{-1} of pp collision data at $\sqrt{s} = 7$ TeV with the ATLAS detector", The ATLAS Collaboration, ATLAS-CONF-2012-011.
- "Search for charged Higgs bosons decaying via $H^\pm \rightarrow \tau + \nu$ in top quark pair events using pp collision data at $\sqrt{s} = 7$ TeV with the ATLAS detector", The ATLAS Collaboration, JHEP 1206 (2012) 039.
- "Triggering on hadronic Tau Decays in ATLAS: Algorithms and Performance", Czodrowski, P., ATL-DAQ-SLIDE-2012-216.
- "Triggering on hadronic Tau Decays in ATLAS: Algorithms and Performance", Czodrowski, P., ATL-DAQ-PROC-2012-039, J. Phys.: Conf. Ser. 396 (2012) 012015.
- "Search for $H^\pm \rightarrow \tau_{\text{had}} + \nu$ in ATLAS", Czodrowski, P., ATL-PHYS-SLIDE-2012-551.
- "Search for $H^\pm \rightarrow \tau_{\text{had}} + \nu$ in ATLAS", Czodrowski, P., ATL-PHYS-PROC-2012-305, submitted to Proceedings of Science.
- "Search for charged Higgs bosons through the violation of lepton universality in $t\bar{t}$ events using pp collision data at $\sqrt{s} = 7$ TeV with the ATLAS experiment", The ATLAS Collaboration, CERN-PH-EP-2012-347 (arXiv:1212.3572 [hep-ex]), submitted to JHEP.

Collaborations

- M. zur Nedden (HU), C. Wasicki and C. Lange (both DESY Zeuthen GK1504).
- Charged Higgs Group of ATLAS (part of HSG6), esp. A. McCarn (Illinois), L. Barak (Rehovot), C. Bernius (Louisiana).
- Tau Working Group of ATLAS, esp. S. Bedikian (Yale), J. Kraus (Bonn).
- Tau Trigger and Trigger Coordination Group of ATLAS.

Selected Talks

- "Searches for Light Charged Higgs Bosons in pp Collisions at $\sqrt{s} = 7$ TeV with ATLAS", TOP2011 Conference, Sant Feliu de Guixols, September 2011.
- "Triggering on hadronic Tau Decays in ATLAS: Algorithms and Performance", CHEP2012 Conference, New York, May 2012.
- "Search for $H^\pm \rightarrow \tau_{\text{had}} + \nu$ in ATLAS", ch⁺arged2012 Workshop, Uppsala, October 2012.

Profit from the GK

- Great additional supervision, input and feedback by GK-advisor.
- Financial support for travel to international conferences.
- Nicely balanced (between theory and experiment) GK-lectures and talks during the GK-blockcourses, given by real experts in the field.
- Efficient knowledge exchange with the other GK-members (new input from Berlin).

Contact Details and further Information

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