Impact on the Low Mass Higgs Sector

Aurore Savoy-Navarro, Matteo Corbo
Stephan Lammel

KIAS Workshop, March 10th, 2011

t,tbar Production

- In a Standard Model world, Matteo would measure two cross-section times branching-ratio^2 that are identical to the dilepton and lepton+b-tag value:

  p,pbar → t,tbar

  → W^+b, W^-b → $\tau^+\nu b$, $\tau^-\nu b$ → $\tau_h\nu\nu b$, $[e\mu]\nu\nu\nu b$

  → W^+b, W^-b → $\tau^+\nu b$, $[e\mu]\nu b$ → $\tau_h\nu\nu b$, $[e\mu]\nu b$

  $\sigma(pp\to tt) \times BR^2(W\to\tau\nu) \times BR(\tau\to[e\mu]\nu\nu) \times BR(\tau\to\tau_h\nu)$

  $\sigma(pp\to tt) \times BR(W\to\tau\nu) \times BR(W\to[e\mu]\nu) \times BR(\tau\to\tau_h\nu)$

  $\sigma(pp\to tt)$ = 7.5 pb

  $BR(W\to\tau\nu)$ = 11.3%

  $BR(W\to[e\mu]\nu)$ = 10.6%

  $BR(\tau\to\tau_h\nu)$ = 64.8%

  (if the direct W and τ cascade decays are distinguished)

Charged Higgs

- A charged Higgs may change this:
  $t \rightarrow H^+b$ and $H^+ \rightarrow \tau\nu$ — H^+ lighter
  $H^+ \rightarrow t,\bar{b}$ — H^+ heavier, $\geq 180\ GeV/c^2$

- from experiments we know:
  $m(H^+) > 78.6\ GeV/c^2$ (Type II, 2HDM)

- A charged Higgs appears in many new theories, any two Higgs-doubled SM extensions, all SUSY models.
- The MSSM Higgs sector is very restricted, at tree level all Higgs values are determined by two parameters ($\tan\beta$, m_A)

- QCD and SUSY-QCD corrections to BR($t \rightarrow H^+b$) are crucial and available for the interpretation

Higgs into Tau Decays

- In the charged Higgs mass range of interest to us, m(H+) < m(t), the BR($H^+ \rightarrow \tau\nu$) ≈ 1

  so we are mixing a BR=1 to the BR($W \rightarrow \tau\nu$) = 11.3%
  i.e. a strong perturbation

- The tau from the charged Higgs decay has also a different polarization:

  $W^- \rightarrow \tau^-_L \, \bar{\nu}_R$
  $H^- \rightarrow \tau^-_R \, \bar{\nu}_R$

  i.e. $P_\tau^H = +1$ and $P_\tau^W = -1$

- The τ^-_R and τ^-_L decay distributions are quite different, the most energetic particles from
  τ^-_L decay transverse polarized
  τ^-_R decay longitudinal polarized

Summary

- Matteo's top analysis gets naturally close to a charged Higgs search
  - it is attractive compared to the H^+H^- cross section
  - it rounds up the top work nicely for Matteo and CDF

- CDF has played previously the measured "cross sections" in different top channels to set limits on charged Higgs parameters.
  - the analysis was based on 200 pb^{-1} only
  - it was not tau specific
  - mainly probed inside the MSSM

- We have no time to loose, LHC resumed operation!