

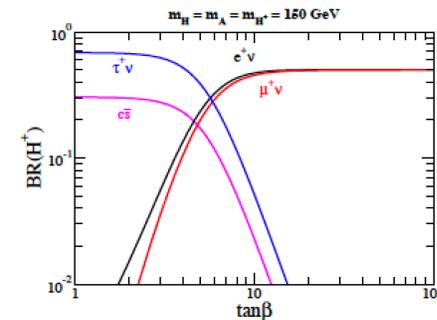
Muonic Decays of Charged Higgs Bosons

In the type I and lepton-specific 2HDMs, the charged Higgs can have a mass well below that of the top quark. In this case, its major decay mode could be into $\tau \nu$. Most LHC studies of charged Higgs in the 80-180 GeV mass range focus on this decay mode. (Other LHC studies look for the $c s$ decay mode).

However, there are models in which the $\mu \nu$ decay mode can be substantial, even dominant. To my knowledge, there have been no searches for this decay mode.

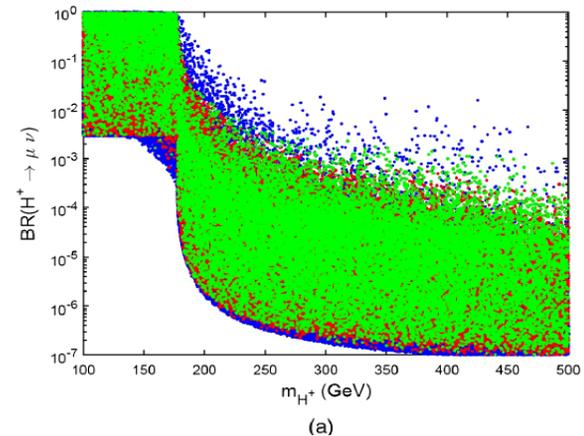
Some motivation for the muonic decay arose following the transient evidence for $h(125) \rightarrow \mu \tau$ a few years ago. The isospin counterpart, which is not suppressed by alignment (i.e. $\cos(\beta-\alpha)$ in the 2HDM) would be $H^+ \rightarrow \tau \nu_\mu + \mu \nu_\tau$. Since the neutrino flavor is not observed, this is just a muonic decay, which can be as high as 50%.

The first model with a substantial muonic BR was by Kajiyama, Okada, Yagyu (1306.6234), which used an S_3 discrete symmetry rather than the usual Z_2 . This was a muon-electron specific model, and the muonic BR can be as high as 50%, as shown \rightarrow



A model based on the $h(125) \rightarrow \mu\tau$ “signal” looked at a 3HDM in which two Higgs couple to leptons and the other to quarks (Merchand, MS, 1611.06887). Here, even for fairly heavy charged Higgs, the muonic branching ratio can be as high as 10%, and for lighter charged Higgs there is a small region of parameter space in which it reaches 50%.

Finally, a 2HDM without FCNC has one Higgs coupling to muons and the other coupling to all other fermions (Abe, Sato, Yagyu, 1705.01469, Ferreira, MS 2002.01000). Here, the green region has acceptable values for the decay BRs of the 125 GeV Higgs. The branching ratio into muons can actually reach 100%.



In many models, the primary production mechanism for a charged Higgs is through top decays into $H^+ b$. Thus, top pair production gives $t\bar{b} H^-$. From that experimenters present limits on $BR(t \rightarrow bH^+)BR(H^+ \rightarrow \tau\nu)$ or $BR(t \rightarrow bH^+)BR(H^+ \rightarrow c\bar{s})$. Suggest also considering limits on $BR(t \rightarrow bH^+)BR(H^+ \rightarrow \mu\nu)$.

In some of the models, however, such as the muon-specific model, the coupling of the charged Higgs to the top quark is suppressed (or the charged mass might be too close to the top mass). In that case, pair or associated production (H^+H^- , $H^+ H$, $H^+ A$) would certainly occur. If the neutral scalars decay primarily to muons, that can lead to tri-muon events, but that becomes much more model dependent.

The point of this note is to simply encourage experimental study of the possibility that a charged Higgs has a substantial branching ratio into $\mu\nu$.