I. INTRODUCTION

The Standard Model (SM) has been almost completed by the discovery of top quark at the Tevatron and the only missing ingredient is the Higgs. LEP I/II experiments were done mainly to discover Higgs but without success up to Higgs mass 114 GeV [1]. Though it rules out small part of the parameter space for the SM Higgs sector, it rules out most of natural parameter space for the minimal supersymmetric standard model (MSSM).

In the MSSM, the quartic coupling of Higgs in the potential is determined from measured gauge couplings and the light CP even Higgs mass has an upper bound of about 120 GeV (which can be 130 or 135 GeV if stop mixing is maximal) [2] [3]. However, this upper bound is achieved only when the stop mass is as heavy as 1 TeV which makes it difficult to understand the weak scale out of it. This 'little hierarchy problem' in the MSSM has been considered seriously for recent several years and many possible extensions of the MSSM have been proposed [4]. Even within the framework of MSSM, it was shown that the boundary condition at high energy which provides negative stop mass squared can reduce the fine tuning for the electroweak symmetry breaking [5] and explicit model has been proposed [6] [7].

As an extension of the MSSM, NMSSM (next to MSSM) is one of the most popular scenarios [8]. Gauge sector extensions also have been proposed [9] [10]. Recently BMSSM (beyond MSSM) has been proposed as a frame to study possible operators which can affect the Higgs sector [11]. There are extra fields above TeV scale but these new states can be integrated out below TeV such that we still keep the spectrum of the MSSM below TeV down to the weak scale. These new TeV particles modify the conventional Higgs potential and can increase the Higgs mass in this setup [11] and also Higgs mixing angle can be significantly changed such that Higgs phenomenology can be quite different from standard one [12]. Electroweak baryogenesis with the light stop in BMSSM has also been studied [13].

The LEP bound is applied to the SM Higgs and in principle it can be weaker in the MSSM, NMSSM or BMSSM if the production or decay is very different from the SM. There had been extensive studies on nonstandard decay of Higgs which can happen if there is an extra light particle (e.g., a singlet of NMSSM) and the decay of Higgs is not just $b\bar{b}$ [14].

In this Letter, we extend the work in the framework of BMSSM [12] which alters the Higgs phenomenology (both production and decay) significantly. We assume that all new states