$W^{\pm}H^{\mp}$ Production at LHC with Subsequent $H^{\pm} \longrightarrow \tau^{\pm}\nu$ Decays

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Motivation

- Search for charged Higgs at LHC

  e.g.

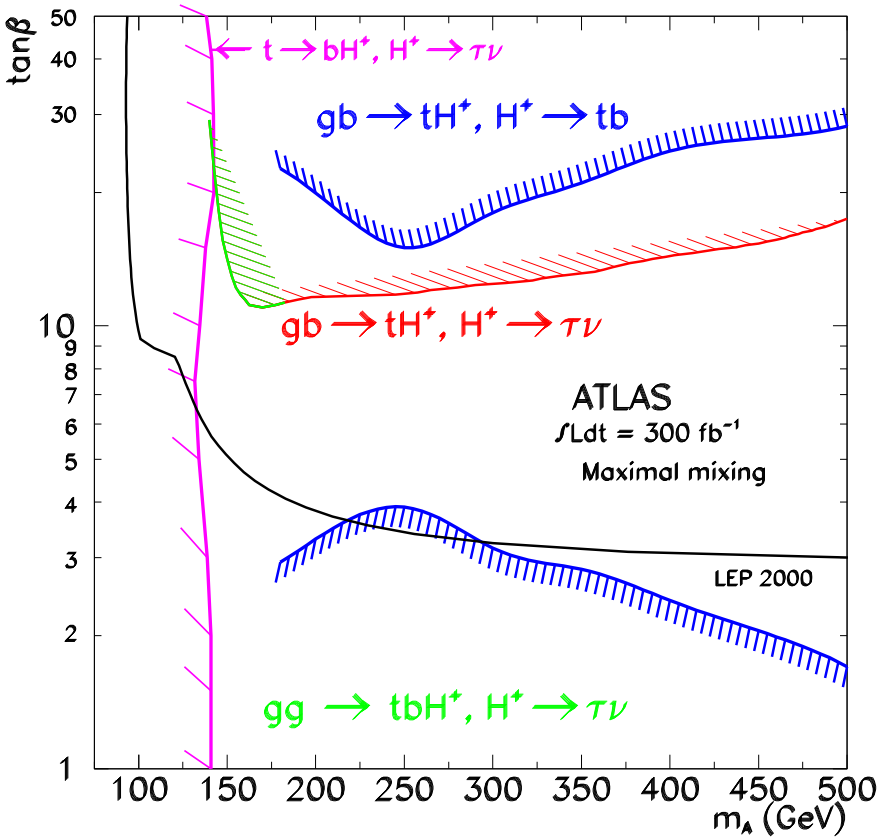
  [Assamagan, Coadou, Deandrea, '02]

  [Assamagan, Guchait, Moretti, '04] $\rightarrow$

  ...

  $\rightarrow$ gap for $m_{H^\pm} \gtrsim m_t$

  and intermediate tan β



- $W^\pm H^\mp$ production and $H^\pm \rightarrow tb$ decay:

  large cross section [Barrientos Bendezú, Kniehl, '98; Brein, '02]

  however, irreducible background from $t\bar{t}$ production [Moretti, Odagiri, '98]

Motivation

- Here: $W^{\pm}H^{\mp}$ production and $H^{\pm} \to \tau^{\pm}\nu$ decay

  Suppression of background by appropriate cuts [Assamagan, Coadou, '02]

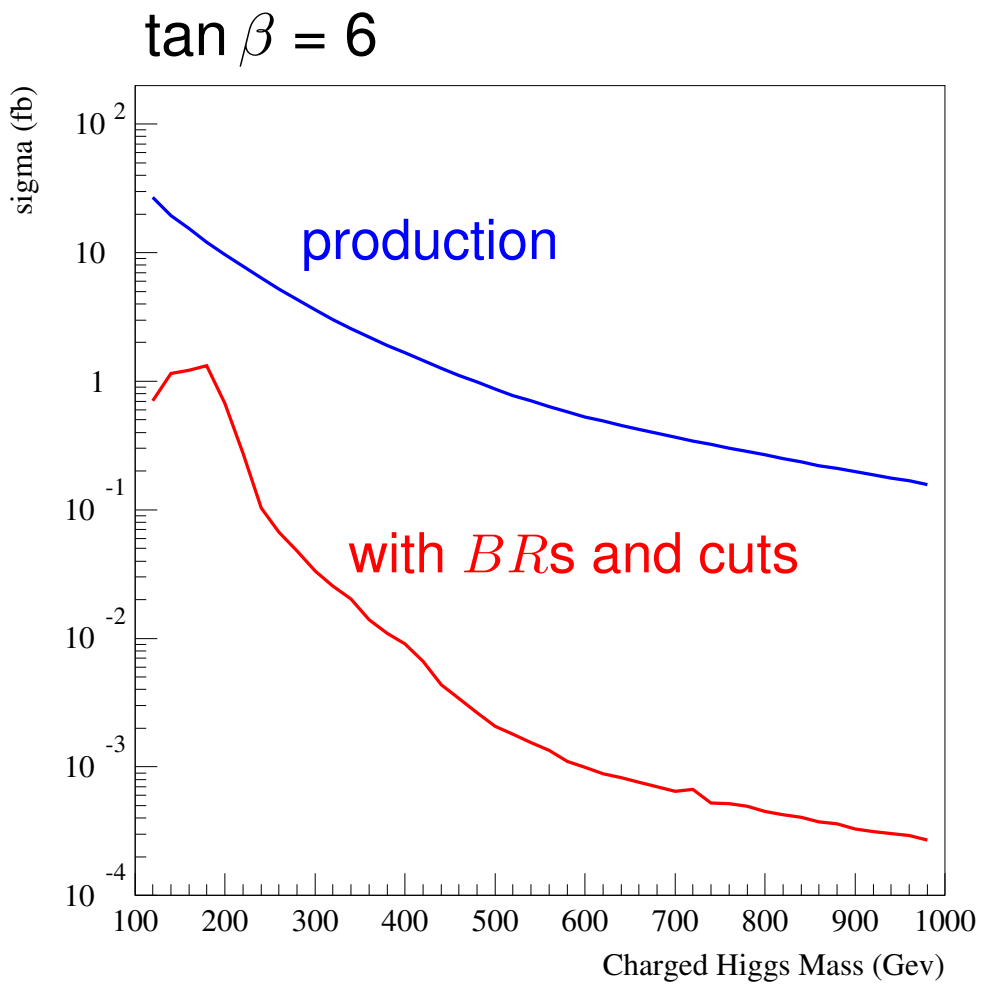
- In complex MSSM or general CP-violating 2HDM

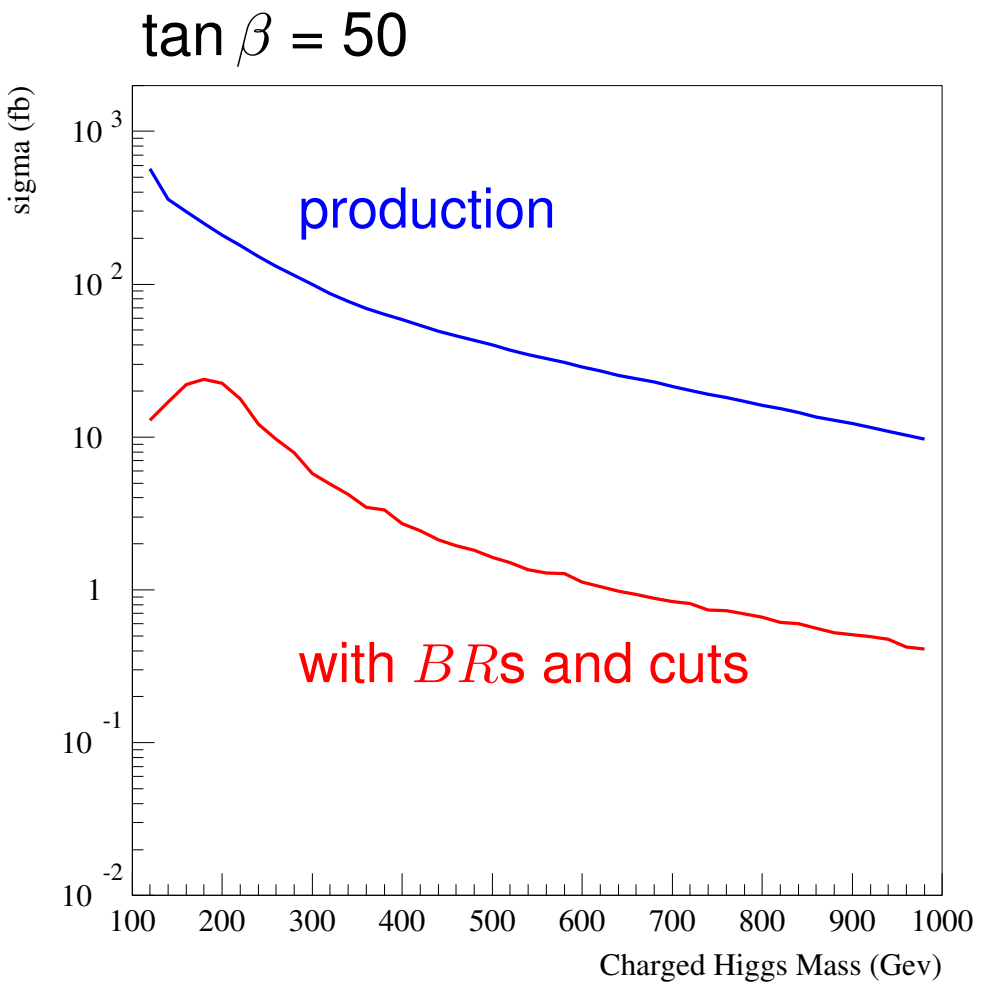
  $\to$ Effects of CP violation (?) [Akeroyd, Baek, '00]

Signal

- $b\bar{b} \longrightarrow W^{\pm}H^{\mp}$
- Implemented as external process in PYTHIA
- Up to now: $\longrightarrow$ Parton level
  $\longrightarrow$ Tree level, however running m_t, m_b and α_{em} in couplings
- Decays $H^{\pm} \longrightarrow \tau\nu$ and $W^{\pm} \longrightarrow jj$ in PYTHIA
- $BR(H^{\pm} \longrightarrow \tau\nu)$ from FeynHiggs
- With initial state radiation: $b\bar{b}$ in final state
  However: preferably in forward/backward region
- Signature: (I) $2j + \tau + \not{p}_{\perp}$ or (II) $2j + \tau + \not{p}_{\perp} + 2b$
- Preliminary results, . . .

Cross section





Background for $W^{\pm}H^{\mp}$ at LHC

- Up to now: Parton level with smearing
- Signature (I): $2j + \tau + \not{p}_{\perp}$
  Signature (II): $2j + \tau + \not{p}_{\perp} + 2b$
- Background (I): $W + 2j$; WW; $WZ + 2j$; $t\bar{t} \to WW + 2b$ and b untagged
  Background (II): $W + 2b + 2j$, $t\bar{t} \to WW + 2b$
- Simulation of (I) with $W + 2$ jets routine of Alpgen
  Cross checks with MadGraph/MadEvent
  and PYTHIA ($t\bar{t} \to WW + 2b$ and b untagged)
- Simulation of (II) with $W + bb + 2$ jets routine of Alpgen
  ($t\bar{t}$ not included)
  $t\bar{t}$ analysed with PYTHIA

Simulation of W + 2 jets with Alpgen

- $\sigma \sim 10^4$ pb without cuts
- "Basic cuts" for background:

  $p_{\perp,\tau} > 60$ GeV, $\not{p}_\perp > 60$ GeV, $p_{\perp,j} > 20$ GeV,

  $\eta_{\tau,j} < 2.5$, $\Delta R(\tau, j) > 0.5$, $\Delta R(j, j) > 0.4$,

  70 GeV$< m_{jj} <$ 90 GeV, $m^T(\tau, \not{p}) > 100$ GeV

  $\Rightarrow$ σ = 250 fb

  (signal: 15 (42) fb for tan β = 30 (50), $m_{H^\pm}$ = 175 GeV)
- Higgs signal in m^T distribution best visible for

  $p_{\perp,j_{\text{soft}}} > 25$ GeV, $p_{\perp,j_{\text{hard}}} > 50$ GeV $\longrightarrow$ σ = 102 fb (signal: 9 (28) fb)
- Cross check with MadEvent:

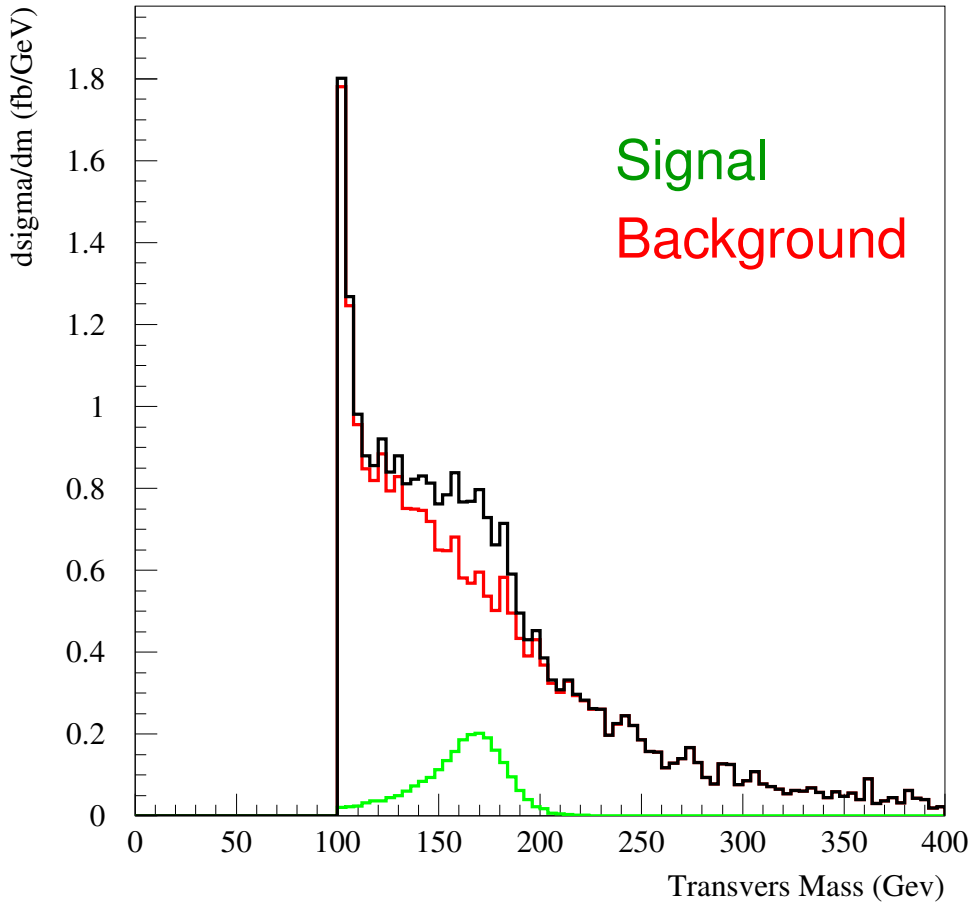
  Process to request: `P P > j j vt ta+`

  Distributions agree well

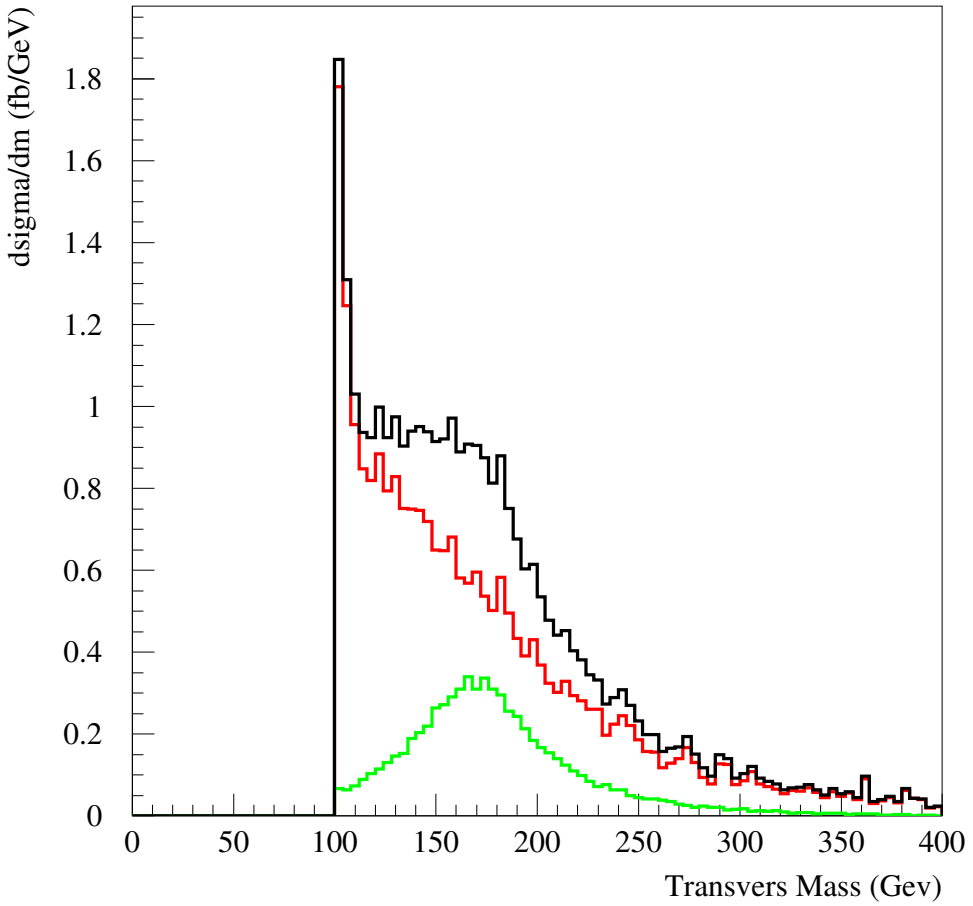
$m^T(\tau, \not{p})$ distribution

For $m_{H^\pm}$ = 175 GeV and cuts $p_{\perp,j_{\text{soft}}} > 25$ GeV, $p_{\perp,j_{\text{hard}}} > 50$ GeV:

tan β = 30



tan β = 50



Simulation of $W + 2b + 2$ jets

- Alpgen
  - With basic cuts:

    $p_{\perp,\tau} >$ 60 GeV, $\not{p}_\perp >$ 60 GeV, $p_{\perp,j} >$ 20 GeV, $p_{\perp,b} >$ 20 GeV,

    $\eta_{\tau,j} <$ 2.5, $\Delta R(\tau, j) >$ 0.5, $\Delta R(j, j) >$ 0.4,

    70 GeV$< m_{jj} <$ 90 GeV, $m^T(\tau, \not{p}) >$ 100 GeV

    $\Rightarrow \sigma$ = 21 fb
  - When both b escape ($p_{\perp,b} <$ 25 GeV or $\eta_b >$ 2.5): $\sigma = \mathcal{O}$(1 fb)
- $t\bar{t}$ with PYTHIA:

  With basic cuts: σ = 16 fb