Probing the CP-violating, light neutral higgs in the charged Higgs decay at the LHC.

D. Ghosh, D. P. Roy ,K. Asamgaan and R.G. in arXiv:hep-ph/0410340; ("Summary of the activities of the working group I on high energy and collider physics (WHEPP8),",

D. Ghosh, D.P. Roy, R.G., Manuscript in preparation.

The CPX Scenario

[Carena, Ellis, Pilaftsis & Wagner, Phys. Lett. **B495** (2000) 155]

"designed to showcase the effects of CP violation in the MSSM"

$$M_{\tilde{Q}_3} = M_{\tilde{U}_3} = M_{\tilde{D}_3} = M_{\tilde{L}_3} = M_{\tilde{E}_3} = M_{\rm SuSy}$$

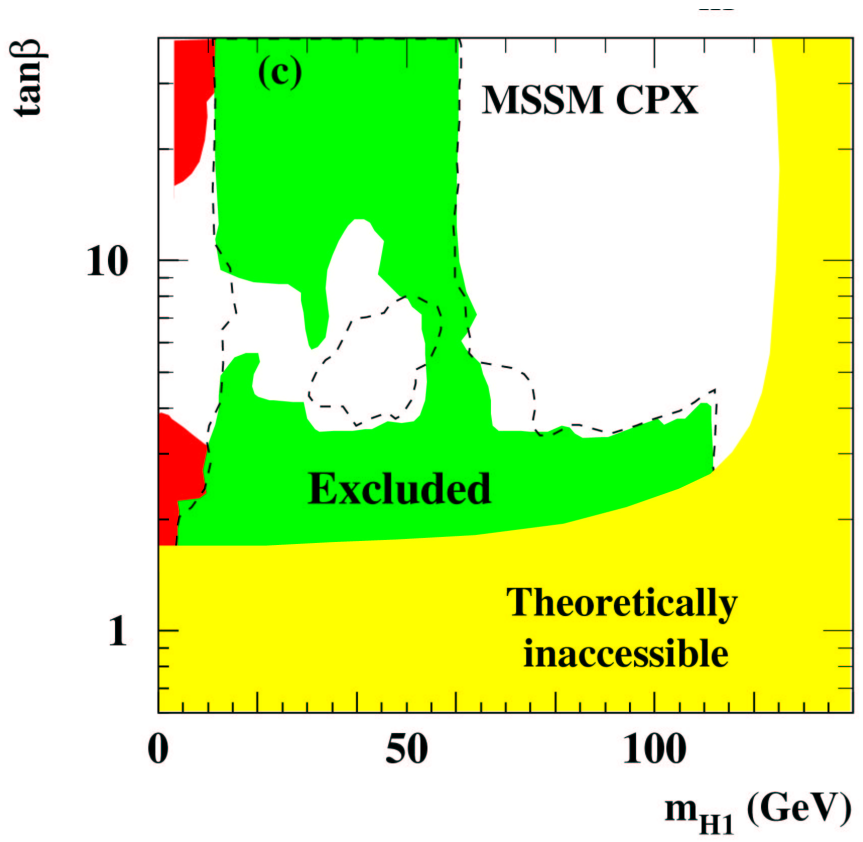
$$\mu = 4M_{\rm SuSy}, \quad |A_{t,b,\tau}| = 2M_{\rm SuSy}, \quad |M_3| = 1TeV$$

Allow the following parameters to vary:

$\tan\beta$,	$M_{H^\pm}$,	$M_{\rm SuSy}$,
$\{\Phi_{A_t}, \Phi_{A_b}, \Phi_{A_\tau}\}$,	Φ_3,	Φ_μ

LEP Limits

OPAL results: Eur. Phys. J. C **37** (2004)



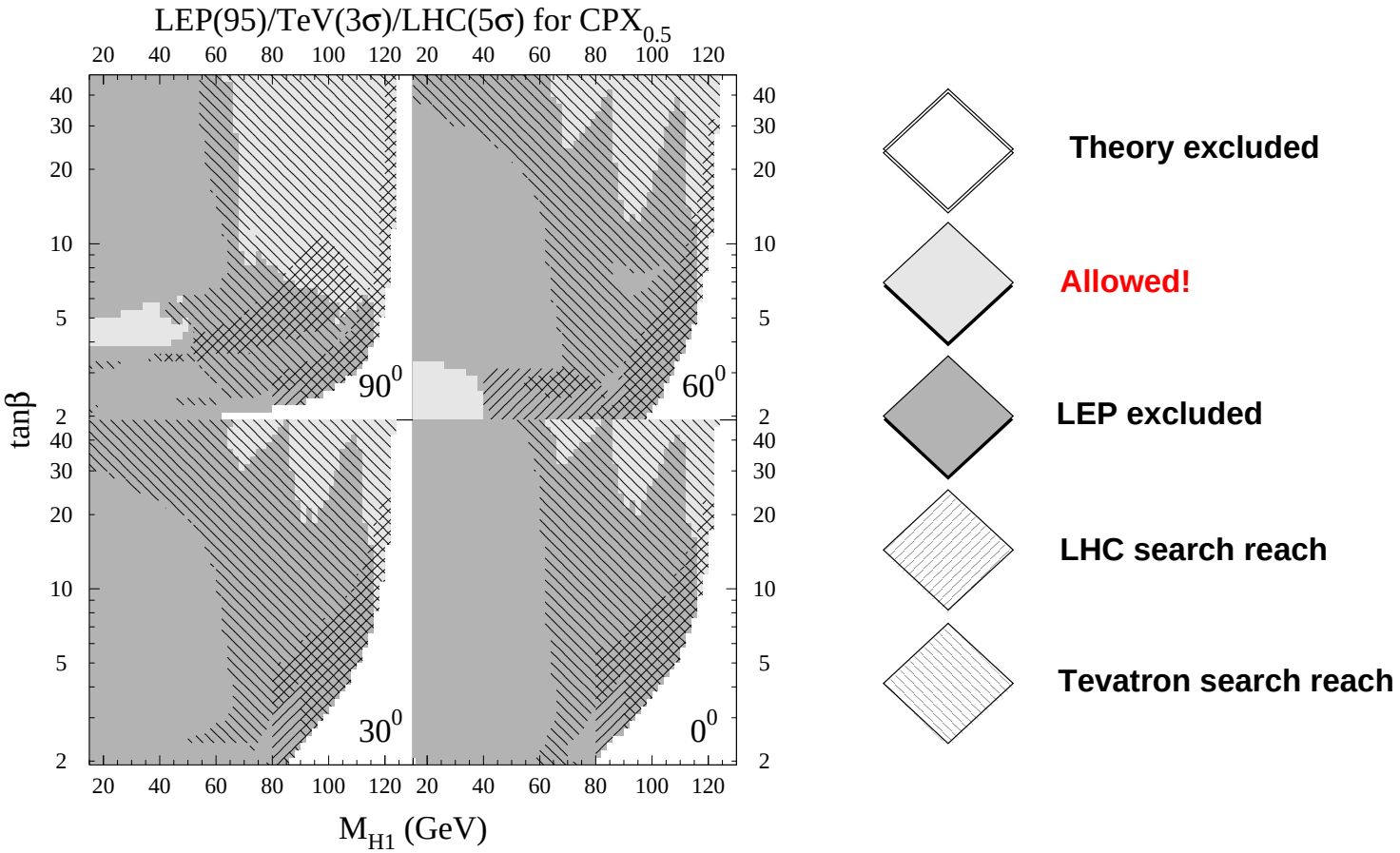
$$\Phi_{A_t} = \Phi_{A_b} = \Phi_{A_\tau} = \Phi_{\tilde{g}} = \frac{\pi}{2}$$

$$\Phi_\mu = 0$$

$$M_{\text{SuSy}} = 500 \text{ GeV}$$

Even have gaps at 0–50 GeV!

[Carena, Ellis, Mrenna, Pilaftsis & Wagner, Nucl. Phys. B **659** (2003) 145]



Gaps in coverage! Need to look at the light higgs searches again.

A few observations

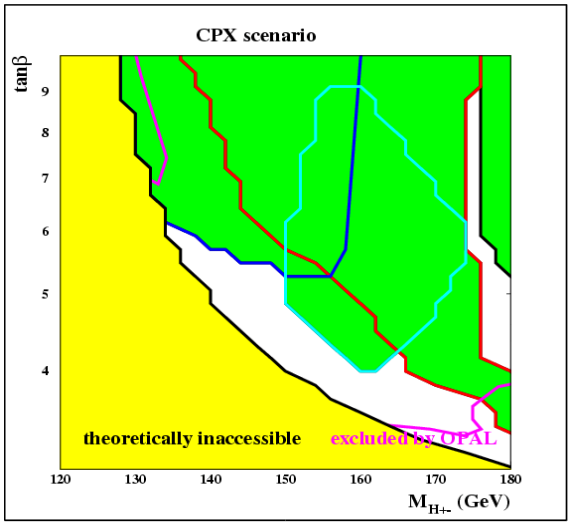
- Small regions in $\tan\beta, M_{H^+}$ plane where LHC,TEVATRON will have no reach

- Caused by reduced ϕ_1 coupling to W/Z AND *top*.

There are regions where the three states will be degenerate, just as discussions of 'intense coupling' regime, Djouadi et al.

The higgs searches in $\not{CP}$ scenario need to be looked at carefully.

What happens to discovery reaches our LHC friends present?



preliminary results presented by M. Schumacher at the meeting on 'CP violation and nonstandard Higgs' //http://kraml.home.cern.ch/kraml/CPstudies/

Warning by M.S.: NOT the official ATLAS results.

A hole in the tan $\beta - M_{H^+}$ plane: for $m_{\phi_1} < 50, 100 < m_{\phi_2} < 110$ and $130 < m_{\phi_3} < 180$.

The results of theory analysis verified.

Suggestion to fill the hole via h^+ decays

Small $\tan\beta$, light $M_{H^+} \Rightarrow$ large $B.R.(H^+ \to \phi_1 W)$.

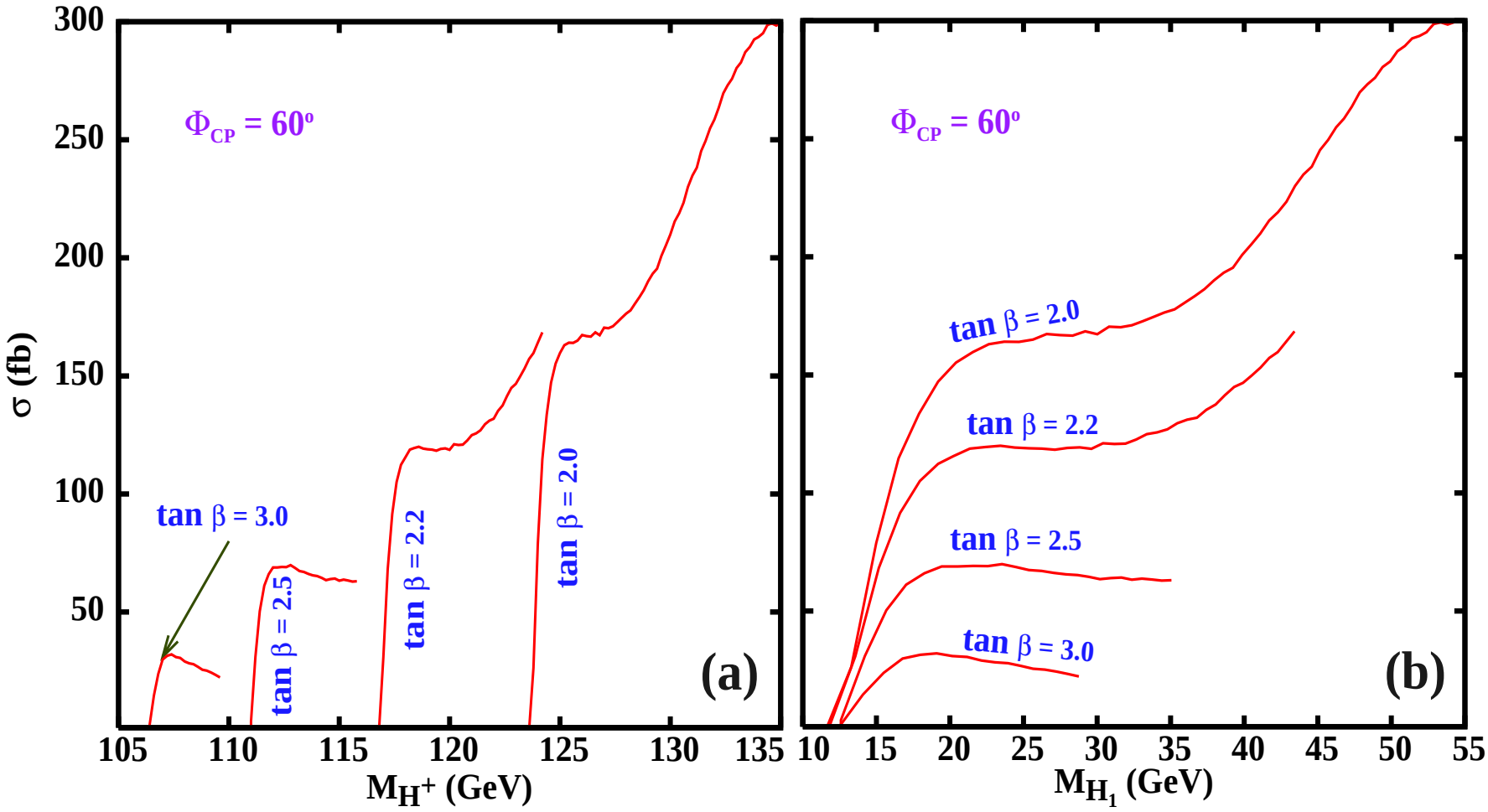
Use $t\bar{t}$ production with :

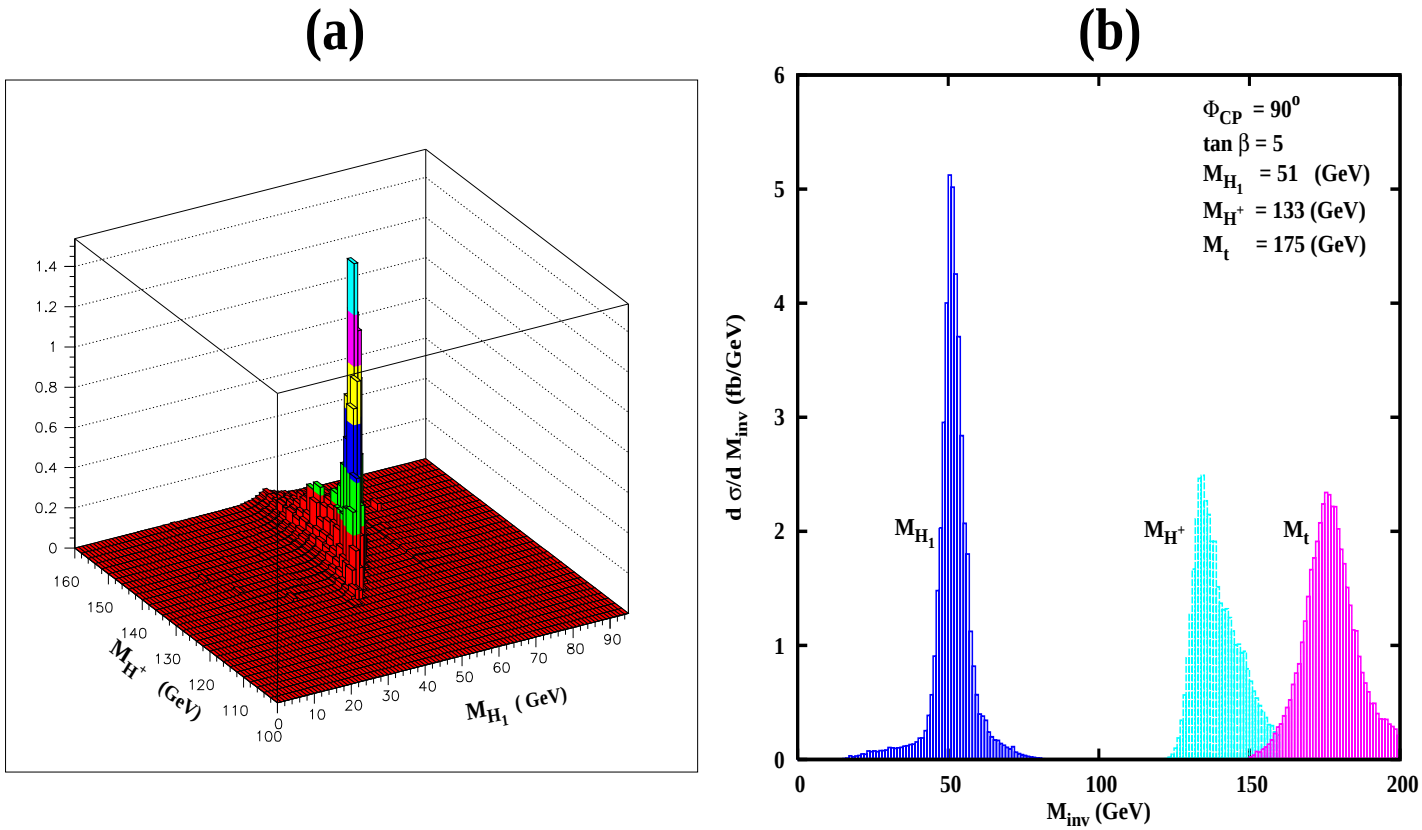
$t \to \bar{b}H^+ \to \bar{b}\phi_1 W \to \bar{b}b\bar{b}W$ and $\bar{t} \to \bar{b}W$, with one W decaying leptonically the other hadronically. Hence both $W's$ can be reconstructed.

Look at the $WWbbbb$ events, 3 tagged $b's$.

1. $|\eta| < 2.5$ for all jets and leptons, where η denotes pseudo-rapidity,
2. p_T of the hardest three jets to be higher than 30 GeV,
3. p_T of all the other jets, lepton, as well as the missing p_T to be larger than 20 GeV,
4. A minimum separation of $\Delta R = 0.4$ between the lepton and jets as well as each pair of jets,
5. Three or more tagged b-jets in the final state assuming a b-tagging efficiency of 50%.

The mass of the $b\bar{b}$ pair with the smallest value will cluster around m_{ϕ_1} and $b\bar{b}W$ around M_{H^+}.


300
250
200
150
100
50
σ (fb)
Φ_CP = 60°
tan β = 3.0
tan β = 2.5
tan β = 2.2
tan β = 2.0
(a)
105
110
115
120
125
130
135
M_H+ (GeV)
Φ_CP = 60°
tan β = 2.0
tan β = 2.2
tan β = 2.5
tan β = 3.0
(b)
10
15
20
25
30
35
40
45
50
55
M_H1 (GeV)



LHC Signal : very clear clustering in the $b\bar{b}$, $b\bar{b}W$ invariant masses corresponding to m_{ϕ_1}, M_{H^+} also in $b\bar{b}bW$ invariant mass at m_t. So detectability controlled by just the signal size.