

# Non-SUSY Charged-Higgs benchmark study

2HDM mostly

Maria Krawczyk, Per Osland + others

Status report, Uppsala, September 2010

# Mailing list - potential participants

Abdesslam Arhrib  
Antonio Racioppi  
Bohdan Grzadkowski  
Dilip Ghosh  
Dorota Sokolowska  
Eilam Gross  
Ekaterina Christova  
Elena Ginina  
J. Lorenzo Diaz Cruz  
Katri Huitu  
Konstantin Kanishchev  
Kristjan Kannike  
Lorenzo Diaz Cruz  
Mahdi Purmohammadi  
Maria Krawczyk  
Mario Kadastik  
Martti Raidal  
Michal Szleper  
Nazila Mahmoudi  
Odd Magne Øgreid  
Oscar Stål  
Riccardo Barbieri  
Rohini Godbole  
Rui Santos  
Shinya Kanemura  
Slava Rychkov  
Stefano Moretti  
Wafaa Khater

## Draft (28 pages)

- Introduction
- Potential and states
- Theoretical constraints
- Experimental constraints
- Yukawa interaction
- Charged Higgs bosons at the LHC - overview
- Benchmarks for the 2HDM II
- Models with several charged scalars
- Models with DM candidates
- Appendix A Yukawa couplings

## Draft (28 pages)

- Introduction
- Potential and states
- Theoretical constraints
- Experimental constraints
- Yukawa interaction
- Charged Higgs bosons at the LHC - overview
- Benchmarks for the 2HDM II
- Models with several charged scalars
- Models with DM candidates
- Appendix A. Yukawa couplings

# Mailing list - potential participants

Abdesslam Arhrib  
Antonio Racioppi  
Bohdan Grzadkowski  
Dilip Ghosh  
Dorota Sokolowska  
Eilam Gross  
Ekaterina Christova  
Elena Ginina  
J. Lorenzo Diaz Cruz  
Katri Huitu  
Konstantin Kanishchev  
Kristjan Kannike  
Lorenzo Diaz Cruz  
Mahdi Purmohammadi  
Maria Krawczyk  
Mario Kadastik  
Martti Raidal  
Michal Szleper  
Nazila Mahmoudi  
Odd Magne Øgreid  
Oscar Stål  
Riccardo Barbieri  
Rohini Godbole  
Rui Santos  
Shinya Kanemura  
Slava Rychkov  
Stefano Moretti  
Wafaa Khater

## Yukawa interactions

Model	$u$	$d$	$\ell$
I	$\Phi_1$	$\Phi_1$	$\Phi_1$
II	$\Phi_2$	$\Phi_1$	$\Phi_1$
III	$\Phi_1 \& \Phi_2$	$\Phi_1 \& \Phi_2$	$\Phi_1 \& \Phi_2$
X	$\Phi_1$	$\Phi_1$	$\Phi_2$
Y	$\Phi_1$	$\Phi_2$	$\Phi_1$

adopted  
terminology

## $Z_2$ symmetric models:

Model	$\lambda^u$	$\lambda^d$	$\lambda^\ell$
I	$-\tan \beta$	$-\tan \beta$	$-\tan \beta$
II	$\cot \beta$	$-\tan \beta$	$-\tan \beta$
X	$-\tan \beta$	$-\tan \beta$	$\cot \beta$
Y	$-\tan \beta$	$\cot \beta$	$-\tan \beta$

## Draft (28 pages)

- Introduction
- Potential and states
- Theoretical constraints
- Experimental constraints
- Yukawa interaction
- Charged Higgs bosons at the LHC - overview
- Benchmarks for the 2HDM II
- Models with several charged scalars
- Models with DM candidates
- Appendix A Yukawa couplings

# Mailing list - potential participants

Abdesslam Arhrib  
Antonio Racioppi  
Bohdan Grzadkowski  
Dilip Ghosh  
Dorota Sokolowska  
Eilam Gross  
Ekaterina Christova  
Elena Ginina  
J. Lorenzo Diaz Cruz  
Katri Huitu  
Konstantin Kanishchev  
Kristjan Kannike  
Lorenzo Diaz Cruz  
Mahdi Purmohammadi  
Maria Krawczyk  
Mario Kadastik  
Martti Raidal  
Michal Szleper  
Nazila Mahmoudi  
Odd Magne Øgreid  
Oscar Stål  
Riccardo Barbieri  
Rohini Godbole  
Rui Santos  
Shinya Kanemura  
Slava Rychkov  
Stefano Moretti  
Wafaa Khater



## Important $H^+$ production processes at the LHC

$$gg, q\bar{q}, b\bar{b} \rightarrow b\bar{t}H^+,$$

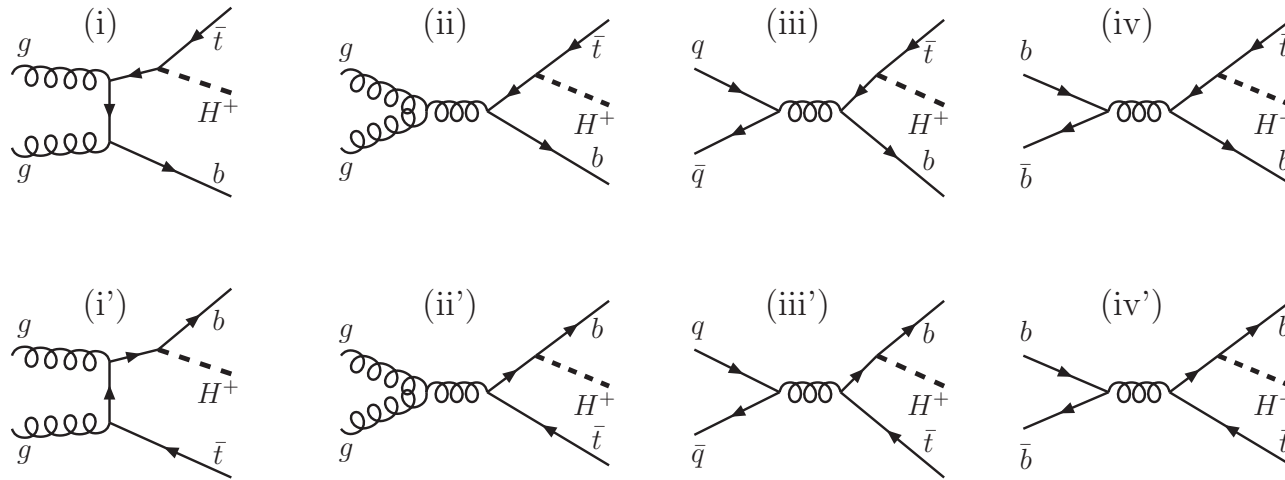
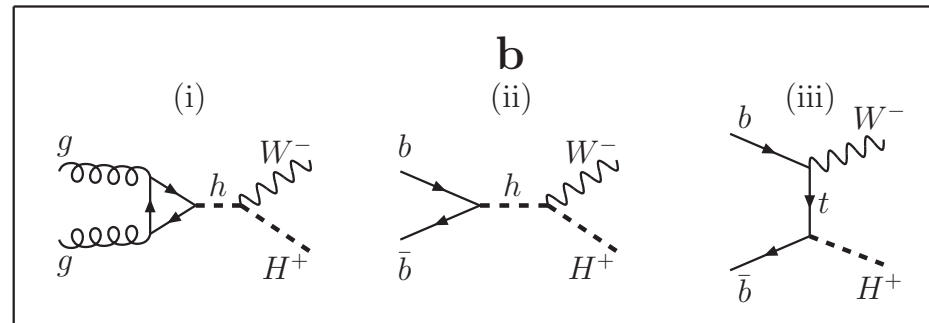
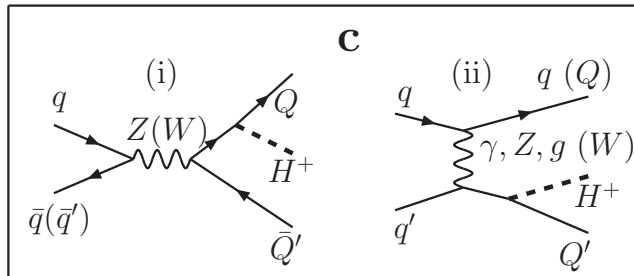
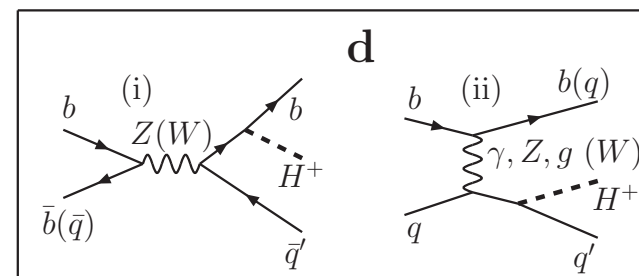
$$gg, b\bar{b} \rightarrow W^- H^+,$$

$$gg, b\bar{b} \rightarrow W^- H^+,$$

$$q\bar{q}' \rightarrow Q\bar{Q}' H^+, \quad q\bar{q} \rightarrow Q\bar{Q} H^+, \quad qQ \rightarrow qQ' H^+$$

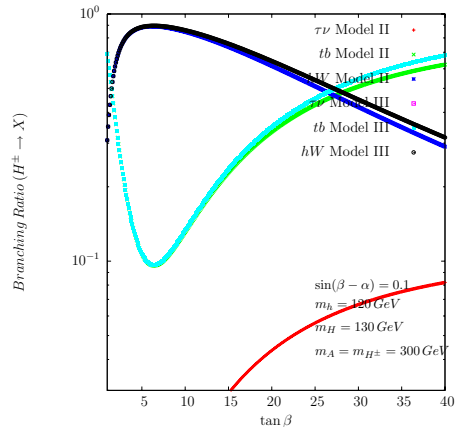
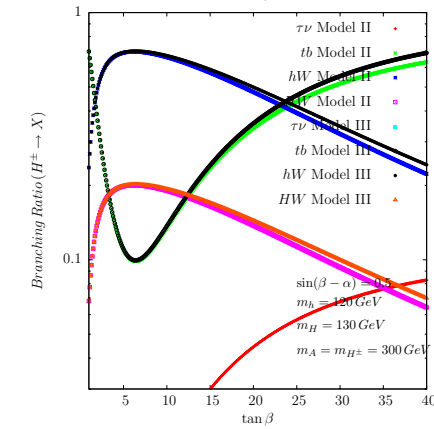
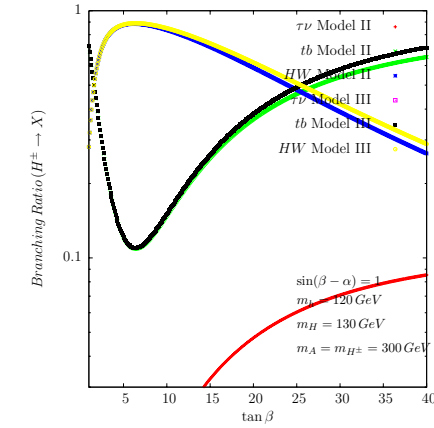
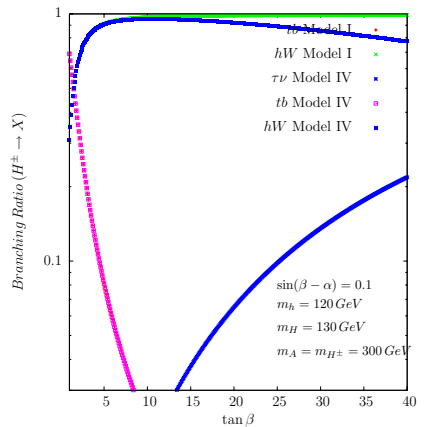
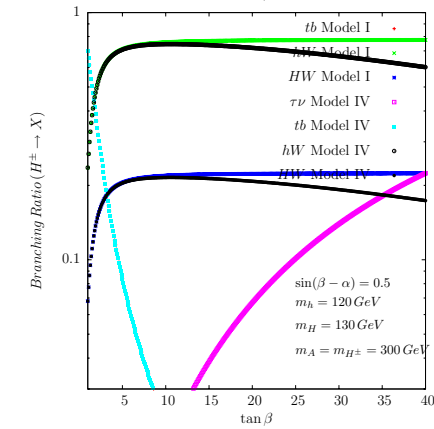
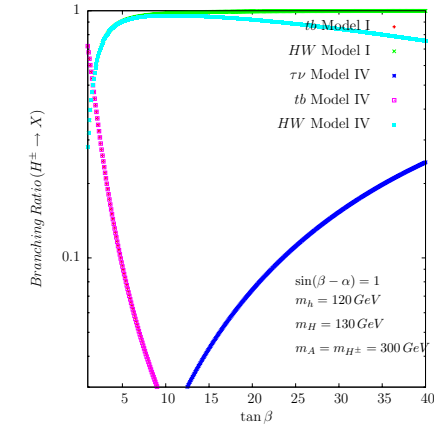
$$b\bar{q} \rightarrow b\bar{q}' H^+, \quad b\bar{b} \rightarrow b\bar{q}' H^+, \quad bq \rightarrow bq' H^+$$

also  $H^+ H^-$  pair production...

**a****b****c****d**

Branching ratios.  
Rui Santos,  
in progress

No constraints  
imposed



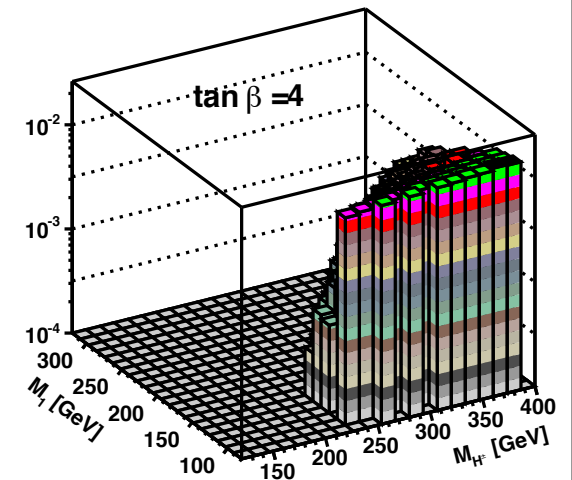
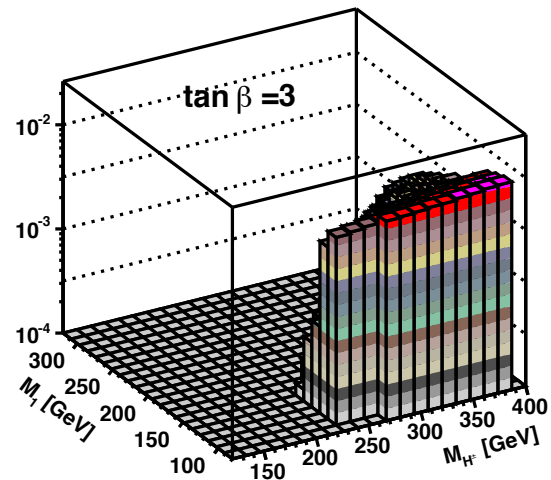
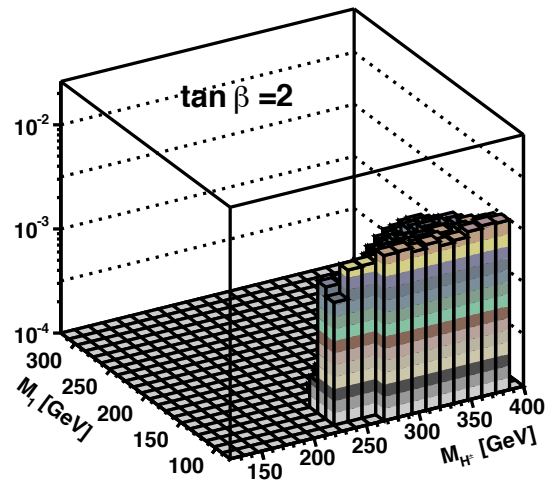
- So far, focus on CP-conserving case (Rui)
- Enhancements of BR's in CP-violating scenario

# Branching ratio, CP-violating case

$$\mathcal{B} = \frac{\Gamma(b\bar{b}W)}{\sum \Gamma(f\bar{f}') + \sum \Gamma(f\bar{f}'H_1)}$$

$M_2 = 300 \text{ GeV}$

$\mu = 200 \text{ GeV}$



# Draft (28 pages)

- Introduction
- Potential and states
- Theoretical constraints
- Experimental constraints
- Yukawa interaction
- Charged Higgs bosons at the LHC - overview
- Benchmarks for the 2HDM II
- Models with several charged scalars
- Models with DM candidates
- Appendix A Yukawa couplings

# Mailing list - potential participants

Abdesslam Arhrib

Antonio Racioppi

Bohdan Grzadkowski

Dilip Ghosh

Dorota Sokolowska

Eilam Gross

Ekaterina Christova

Elena Ginina

J. Lorenzo Diaz Cruz

Katri Huitu

Konstantin Kanishchev

Kristjan Kannike

Lorenzo Diaz Cruz

Mahdi Purmohammadi

Maria Krawczyk

Mario Kadastik

Martti Raidal

Michal Szleper

Nazila Mahmoudi

Odd Magne Øgreid

Oscar Stål

Riccardo Barbieri

Rohini Godbole

Rui Santos

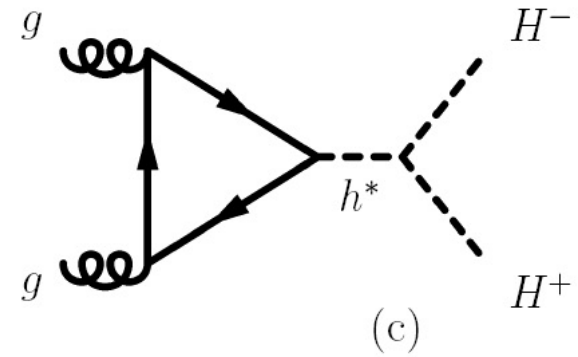
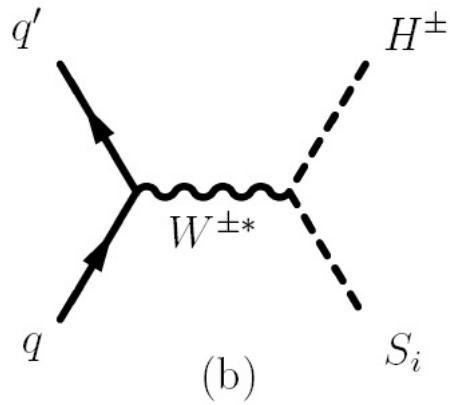
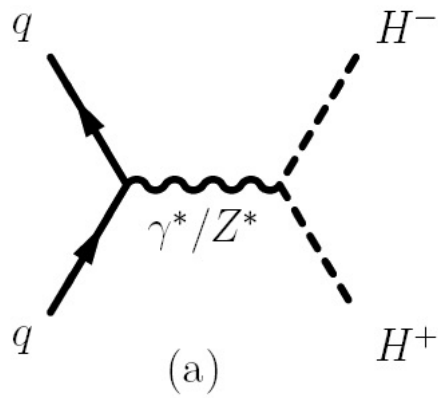
Shinya Kanemura

Slava Rychkov

Stefano Moretti

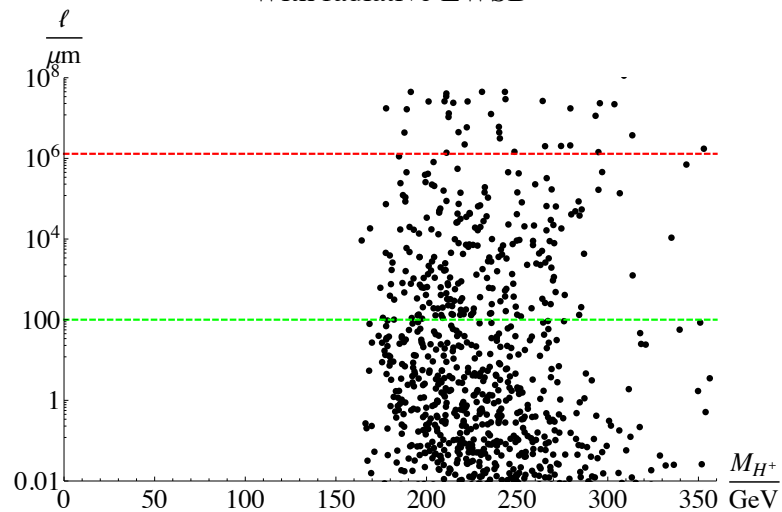
Wafaa Khater

# DM Model by Raidal et al



With radiative EWSB

Long-lived  $H^+$   
 → Displaced vertices





- Complete CV-conserving part
- Extend to CP-violating model
- Interact with experimentalists!

- Complete CV-conserving part
- Extend to CP-violating model
- Interact with experimentalists!

# Mailing list - potential participants

Abdesslam Arhrib

Antonio Racioppi

Bohdan Grzadkowski

Dilip Ghosh

Dorota Sokolowska

Eilam Gross

Ekaterina Christova

Elena Ginina

J. Lorenzo Diaz Cruz

Katri Huitu

Konstantin Kanishchev

Kristjan Kannike

Lorenzo Diaz Cruz

Mahdi Purmohammadi

Maria Krawczyk

Mario Kadastik

Martti Raidal

Michal Szleper

Nazila Mahmoudi

Odd Magne Øgreid

Oscar Stål

Riccardo Barbieri

Rohini Godbole

Rui Santos

Shinya Kanemura

Slava Rychkov

Stefano Moretti

Wafaa Khater