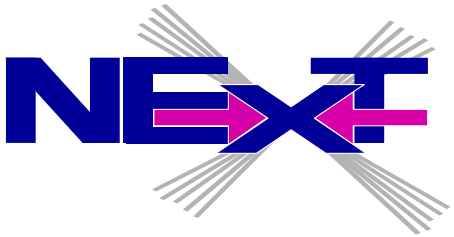
‘Charged 2010’, Uppsala, 30 Sep 2010

Theory Summary & Outlook

Stefano Moretti (NExT Institute)



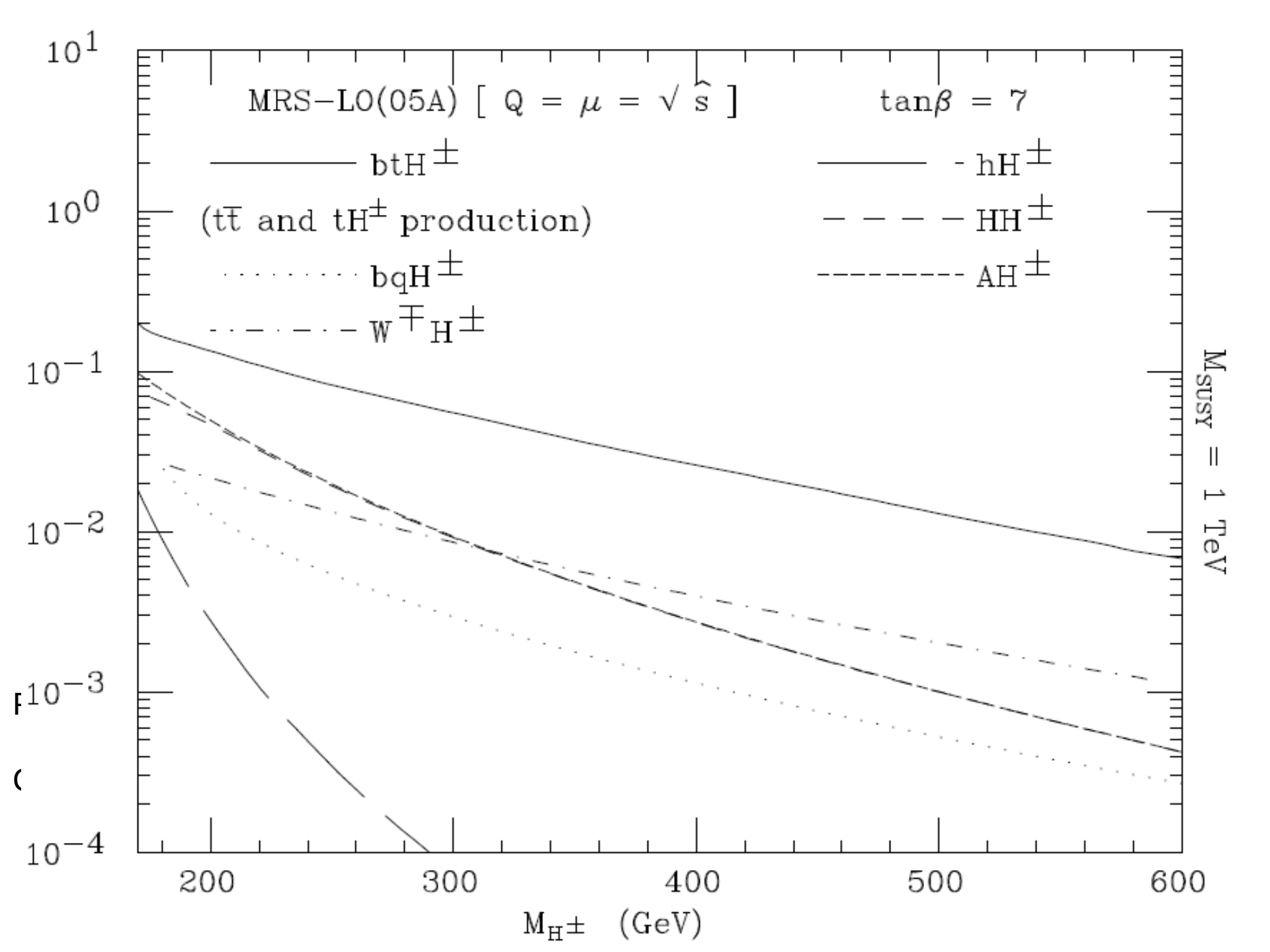
Will attempt to review progress since Charged 2008

0. Thanks to Hurth, Akeroyd, Stal for their reviews (will not touch upon here).

1. New (production and/or decay) processes (Dermisek, Santos, Zaro)

2. New/Improved calculations/tools (Kraemer, Plehn, Brein, Rathsman, Mahmoudi, Heinemeyer, Verzegnassi, Kolda)

3. New models & their phenomenological implications (Ginzburg, Gustafsson, Cagil, Wouda, Jung, Hernandez) - `new' means here those which have not undergone the same phenomenological scrutiny as the MSSM, NMSSM & 2HDMs


MRS−LO(05A) [Q = μ = √ ŝ]
tanβ = 7
btH±
(tt̄ and tH± production)
bqH±
W∓H±
-hH±
HH±
AH±
10^1
10^0
10^−1
10^−2
10^−3
10^−4
200
300
400
500
600
M_H± (GeV)
M_susy = 1 TeV

Santos et al

$$pp \to H^+ h(A) \to \tau^+\nu\, b\bar{b} \to \pi^+ \bar{\nu}\, \nu b\bar{b}$$

H+

Higgs pair production

$$\begin{cases} q\bar{q} \to H^+H^- \\ b\bar{b} \to H^+H^- \\ gg \to H^+H^- \end{cases}$$

All tanβ

$$\sigma^{I}_{q\bar{q}\to H^+H^-} > \sigma^{I}_{gg\to H^+H^-} > \sigma^{I}_{b\bar{b}\to H^+H^-}$$

$$\sigma^{II}_{q\bar{q}\to H^+H^-} > \sigma^{II}_{gg\to H^+H^-} > \sigma^{II}_{b\bar{b}\to H^+H^-}$$

low tanβ

high tanβ

$$\sigma^{II}_{gg\to H^+H^-} > \sigma^{II}_{q\bar{q}\to H^+H^-} > \sigma^{II}_{b\bar{b}\to H^+H^-}$$

Alves and Plehn 2005

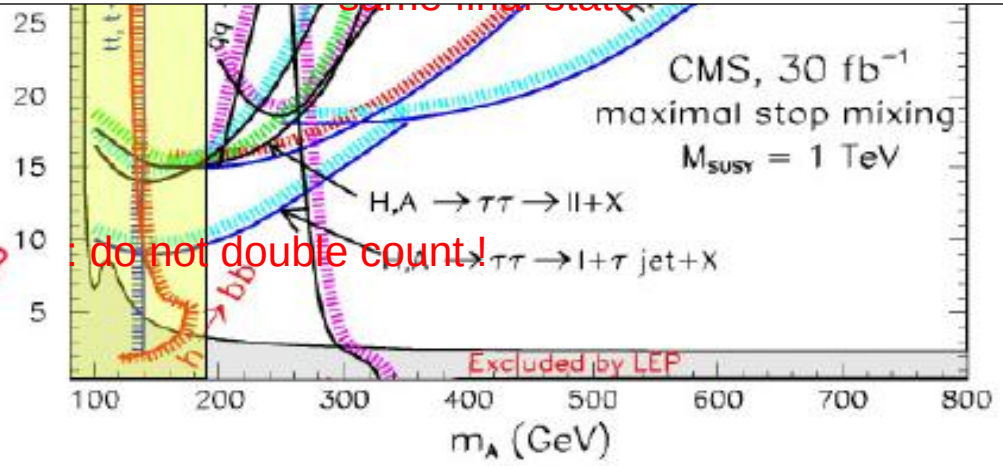
Not

...ress)

...ignature

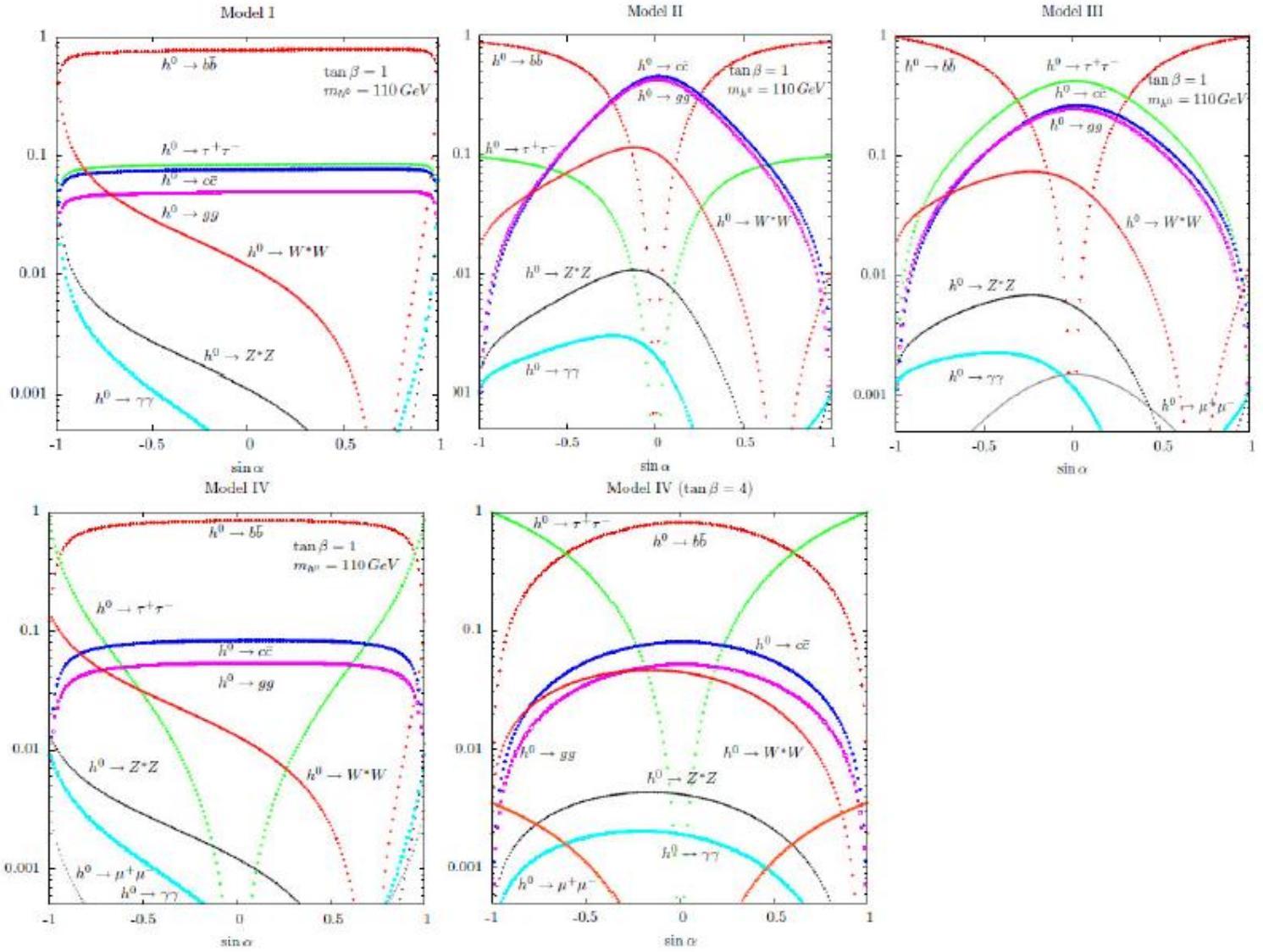
...Kanemura et al Type X model

Need to adopt a new mixing scenario after the demise of min max ?



: do not double count !

Scope of neutral Higgs decays in distinguishing between 2HDMs is better



Zaro

New production processes ?

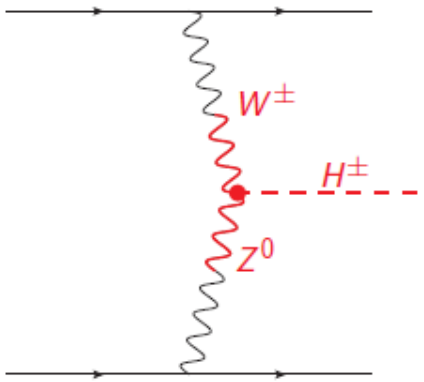
Charged Higgs production via VBF

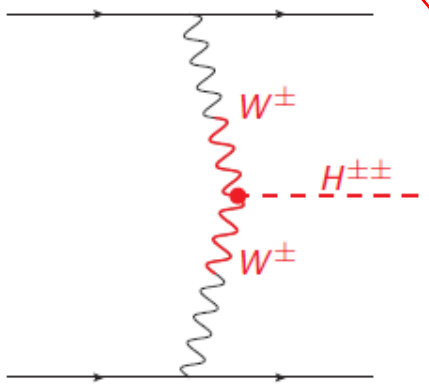
- Several models
- Different representation for Higgs multiplets
  - Triplet models (LH, GM, L-R) contain a $W^{\pm}Z^{0} \rightarrow H^{\pm}$ vertex at tree level
  - Doubly charged Higgs included in these models

for a review of feynman rules, see **Godfrey, Moats: arXiv:1003.3033**

  - Charged Higgs production via VBF allowed and visible @LHC

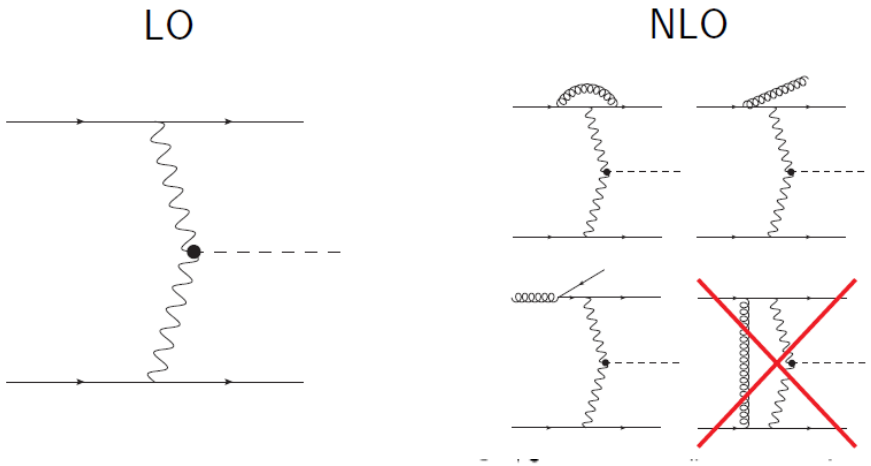
Asakawa, Kanemura, Kanazaki: arXiv:hep-ph/0612271

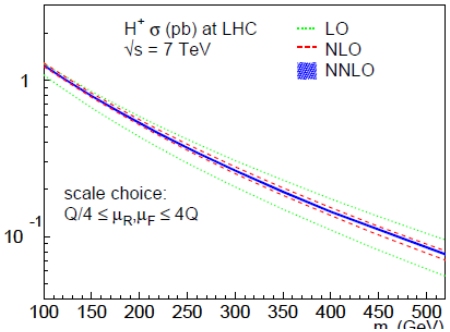


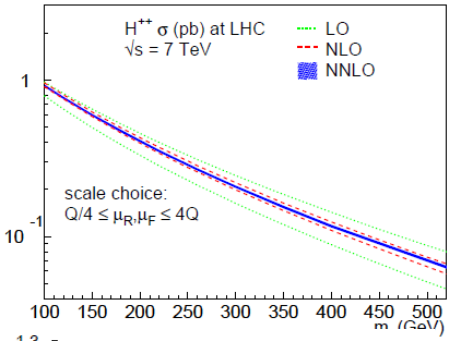


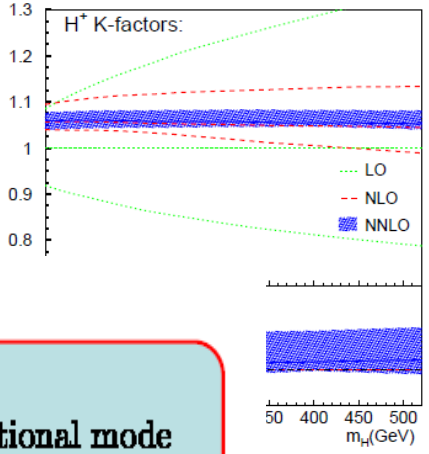
(potentially)

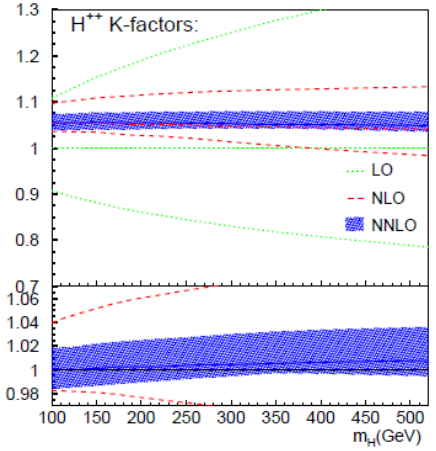
QCD corrections to VBF



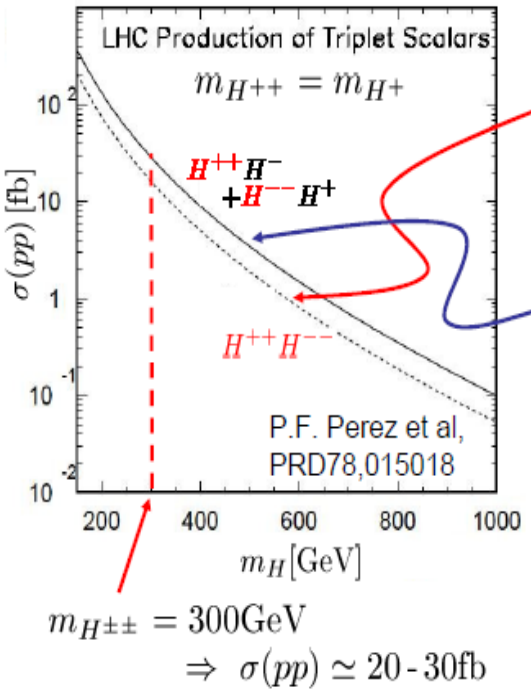


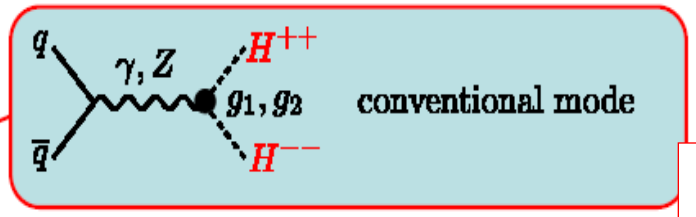


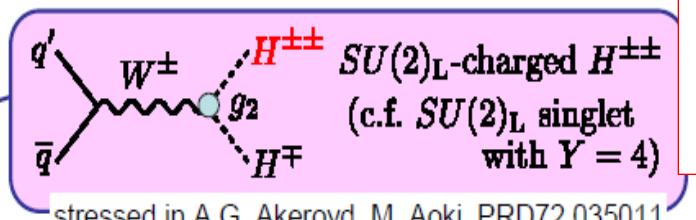




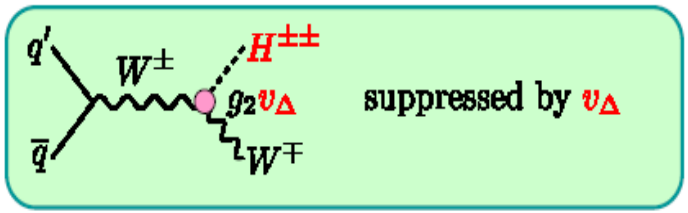
Production at hadron collider :







stressed in A.G. Akeroyd, M. Aoki, PRD72,035011



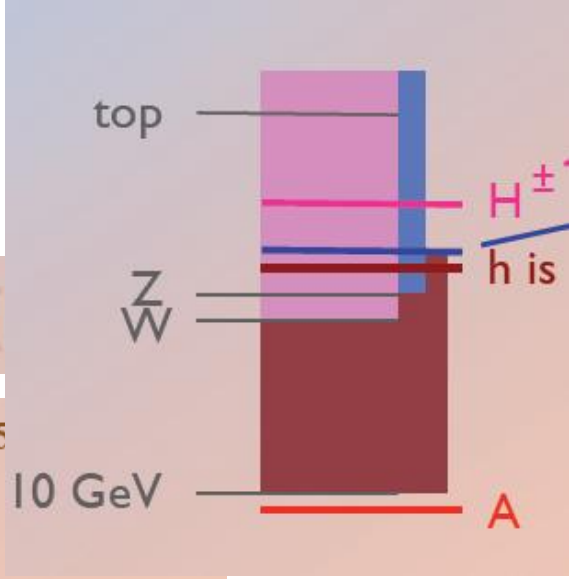
Nice but careful, rates assume TeV scale vev for doublet, quite unnatural, ought to be much lower

:onvergence of perturbative series

uncertainties reduced at $\pm 2\%_{SC}$ level at NNLO

fferential calculation (at least at NLO)

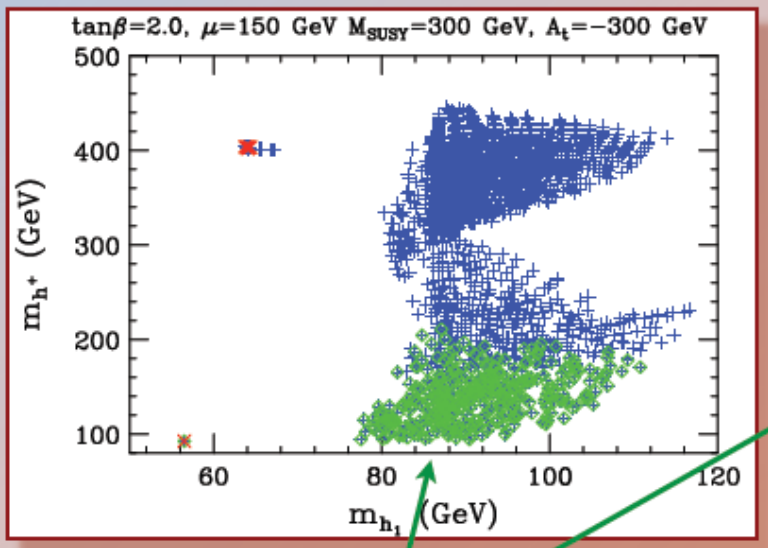
New decay processes ?



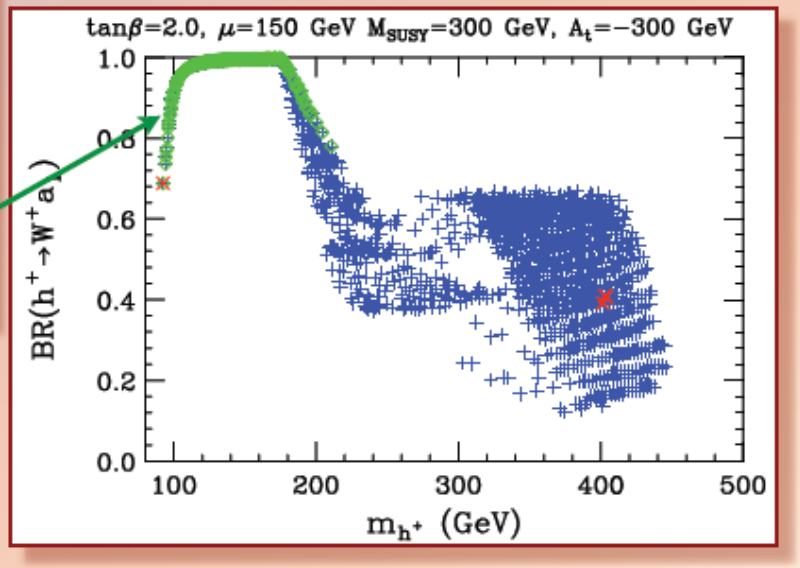
Light Charged Higgs in the NMSSM

R.D., arXiv:0806.0847 [hep-ph], R.D. and J. Gunion, arXiv:0811.3537 [hep-ph] 35

In the NMSSM the scenario is generically viable:



viable e.g. in NMSSM for $\tan\beta \lesssim 3$



green points indicate scenarios with a doublet-like light CP odd Higgs

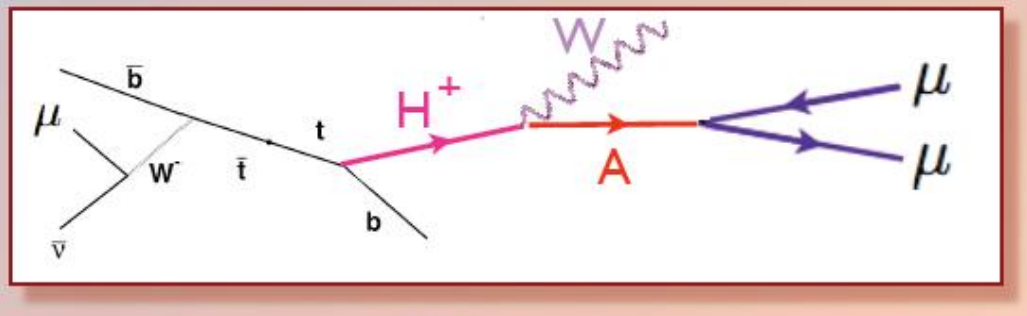
Charged Higgs at the LHC

~ 100 GeV

R.D., E. Lunghi and A. Raval, in progress

LHC is a top factory: 200 000 top pairs at 7 TeV with 1 fb^{-1}

it is advantageous to search for a subleading decay mode:



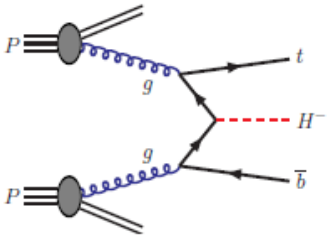
- **one of the two Ws:** $W \to \mu\nu$ **20%**
- **CP-odd Higgs:** $a \to \mu\mu$ **1/250**
- **for** $Br(t \to H^+ b) = 10\%$ **we have ~30 clean 3-muon events!**

Allowed by CDF 2010

New/Improved calculations/tools

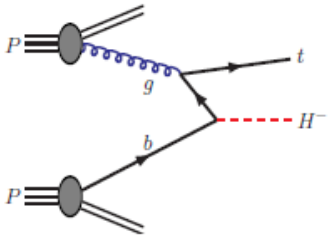
Associate $tbH^{\pm}$ production: two calculational schemes

4-flavour scheme



+ exact $g \to b\bar{b}$ splitting & mass effects
− no summation of $\ln(M_H/M_b)$ terms

5-flavour scheme



+ summation of $\ln(M_H/M_b)$ terms
− LL approximation to $g \to b\bar{b}$ splitting

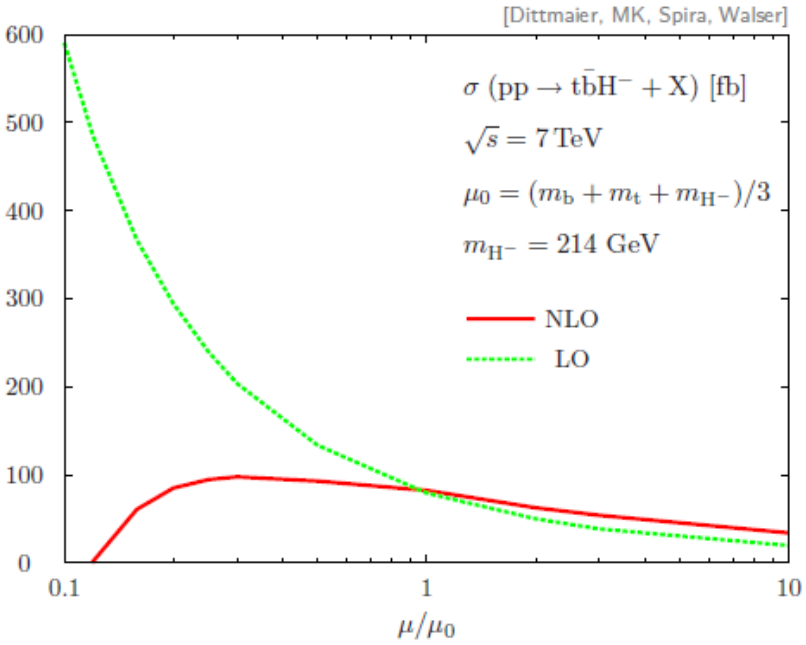
The 4- and 5-flavour schemes

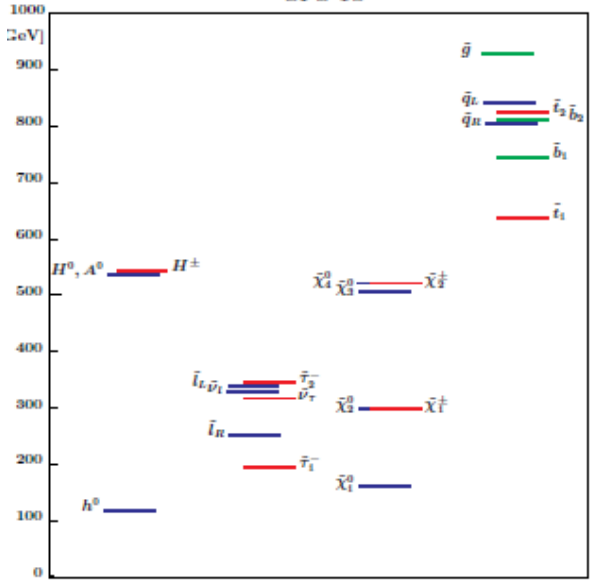
- are both theoretically consistent & well-defined
- represent different ways of ordering perturbation theory
- should agree at sufficiently high order
- do not match exactly at finite order

Does NOT assume sparticles decoupled

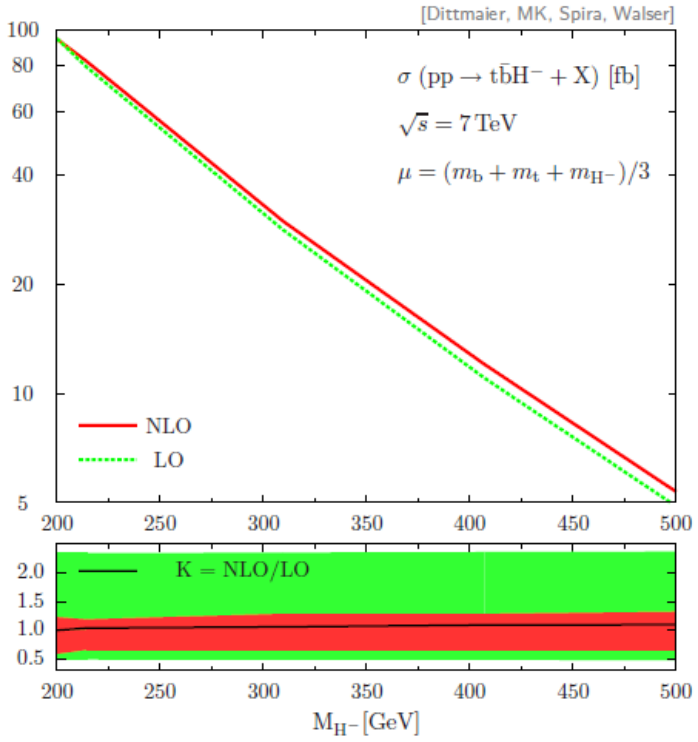
Here: ▸ 4FS NLO SUSY-QCD [Peng et al.; Dittmaier et al.]

- scale dependence at 7 TeV (here and in the following we use SPS1b)



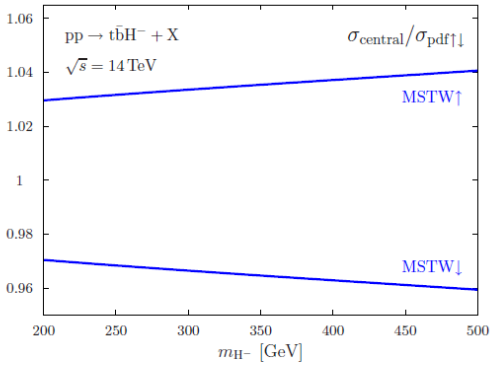


- total cross section at 7 TeV



$\rightarrow \Delta\sigma = \pm\ 100\%$ (LO) and $\pm\ 25\%$ (NLO)

- total cross section with MSTW08 4FS pdf



$\rightarrow \Delta\text{pdf} \lesssim 5\%$

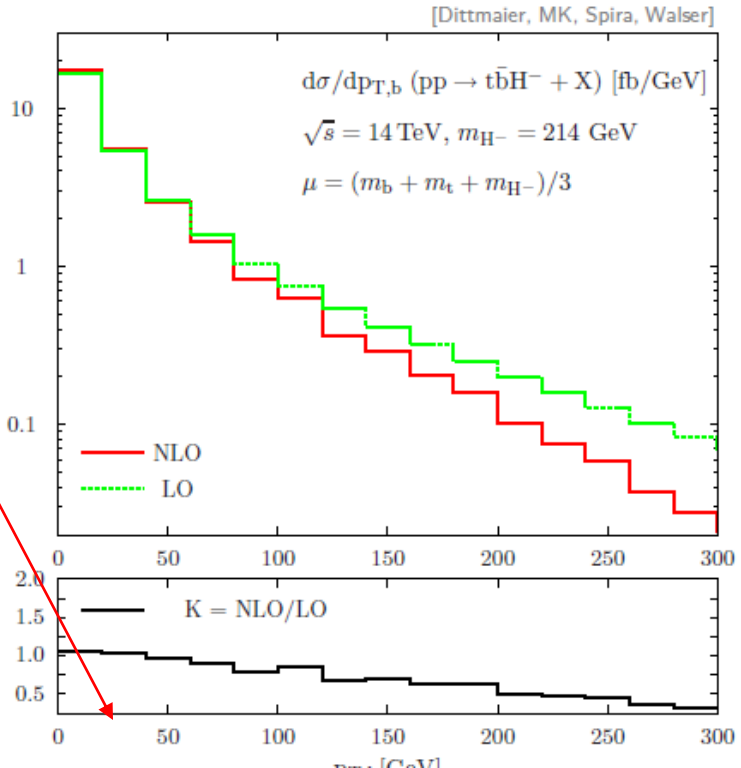
- total cross section (14 TeV): individual NLO contributions

$$\sigma_{\rm NLO} = \sigma_0 \times (1 + \delta^{\tan\beta-{\rm resum.}}_{\rm SUSY-QCD}) \times (1 + \delta_{\rm QCD} + \delta^{\rm remainder}_{\rm SUSY-QCD})$$

$M_{\rm H^\pm}$ [GeV]	σ_0 [fb]	$\delta_{\rm QCD}$	$\delta^{\tan\beta-{\rm resum.}}_{\rm SUSY-QCD}$	$\delta^{\rm remainder}_{\rm SUSY-QCD}$
214	545	0.57	−0.30	−0.002
310	234	0.61	−0.30	−0.002
407	109	0.63	−0.30	−0.002

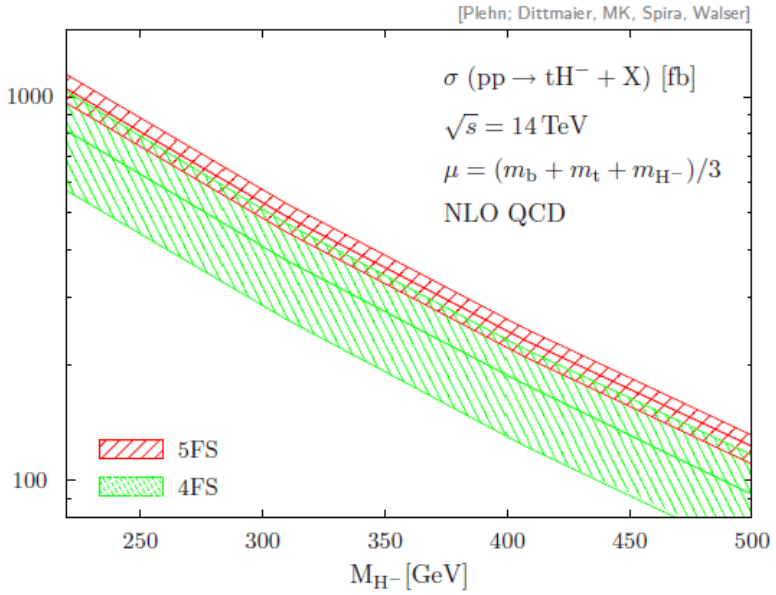
- partial cancellation between QCD and SUSY-QCD corrections
  - bottom transverse momentum distribution at LO/NLO

At NLO b tagging eff is depleted



- total cross section

Comparison of 4 and 5FS calculations at NLO



We should

- complete the pdf and α_s uncertainty analysis;
- study the factorization of SUSY corrections for a wider range of scenarios; → Coordinate with MSSM benchmark WGs
- pursue the comparison of 4FS and 5FS calculations for distributions;
- combine the NLO SUSY-QCD and EWK corrections;
- match the 4FS calculation with parton showers;
- include the decay of the Higgs and the top.
- consider the transition region where $m_H \approx m_\text{top}$; → combine 4&5FS

Probably unrealistic for several years

Top-Higgs in MC@NLO

Tilman Plehn

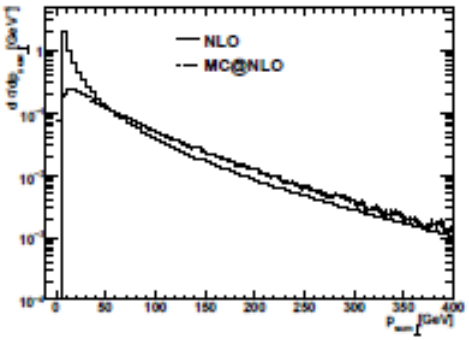
why combining NLO/hard radiation/parton shower?

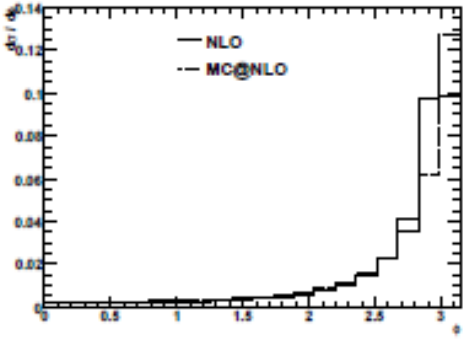
- promised at end of CHARGED06
- parton shower for jet and recoil simulations [Alwall & Rathsmann: MATCHING]
  NLO normalization to reduce scale issues [Boos & TP: scales of bottom pdf]
  complete bottom jet kinematics for analysis design
- implementation in MC@NLO the solution

  [Frixione, Herquet, Klasen, Laenen, TP, Stavenga, Weydert, White]

top and Higgs distributions from MC@NLO

- top identical for NLO and MC@NLO
- Higgs identical for NLO and MC@NLO
- QCD recoil different for NLO and MC@NLO [hard radiation plus parton shower]
- angular correlations different for NLO and MC@NLO





Bottom jets

decay jets vs jet radiation [TP, Rauch, Spannowsky]

- H_ℓ combined with t_h or t_ℓ
- hardest bottom jet with a jacobian peak [top decay]
  second bottom jet collinear [hard or shower, how hard?]
- t_ℓ: all light jets from QCD
- t_h: three light jets from top decay

$\Rightarrow$ distinctly different, hopefully useful

more QCD questions we can answer now

- probability to in addition to a b jet observe [$|\eta| < 2.5; p_T > 25$ GeV]
  (a) a light jet from t_ℓ
  (b) a light jet from t_h
  (c) a second b jet

	$p_{T,\mathrm{cut}}$	η_{cut} 2.5	2.0	1.5	1.0	0.5
(a)	25 GeV	45.9	40.0	32.7	23.9	13.0
	45 GeV	32.4	27.8	22.3	16.1	9.0
	65 GeV	22.3	18.8	14.7	10.4	5.8
	85 GeV	16.2	13.4	10.3	7.3	4.2
(b)	25 GeV	94.9	91.0	84.3	72.2	48.4
	45 GeV	83.2	79.2	72.3	61.0	39.9
	65 GeV	60.9	57.3	51.7	43.2	28.8
	85 GeV	44.4	41.5	37.1	31.1	21.3
(c)	25 GeV	17.8	14.3	10.0	5.7	2.3
	45 GeV	12.9	10.6	7.6	4.5	1.8
	65 GeV	9.4	8.0	5.9	3.5	1.6
	85 GeV	7.2	6.4	4.8	3.0	1.4

- light jets everywhere
  not only soft and now only forward
- second bottom rare [gluon splitting vs decay?]
- jet radiation correct for all p_T and η

Tagging tops from charged Higgses

Anyone interested?

- $H^+ \to t\bar{b}$ agreed to be impossible
  killed by continuum $t\bar{t}b\bar{b}$
- look for boosted tops
  reconstruct with jet algorithm [TP, Salam,
  reduce QCD and combinato
  reconstruct 4-momentum
  promising for $t\bar{t}h^0, h^0 \to b\bar{b}$

Outlook: now high time to do S/B analyses @ NLO as tt-bar also in MC@NLO

Needs validation against data, use twin process bg->tW+ from MC@NLO

One-loop SUSY EW effects onto:

Verzegnassi

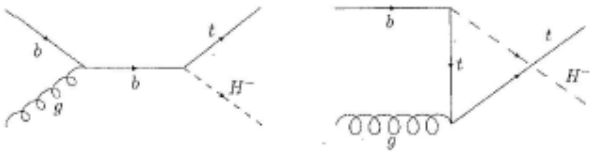


Figure 1: Born diagrams: s-channel bottom exchange and u-channel top exchange.

1. Assume 2HDM & MSSM (mSUGRA inspired)
2. No radiation of (real) W, Z
3. Includes QED corrections
4. Calculation done in Dimensional Reduction
5. Full calculation well approximated by effective Lagrangian with modified b mass

$$\mathcal{L}^{(eff)}_{Ym} = \frac{1}{v}\,\frac{\overline{m}_b(Q)}{1+\Delta m_b}\cdot$$

$$\left\{\left[\frac{\sin\alpha}{\cos\beta} - \Delta m_b \frac{\cos\alpha}{\sin\beta}\right]\bar{b}\,b\,h_0 +\right.$$

$$+\left[\frac{-\cos\alpha}{\cos\beta} + \Delta m_b \frac{\sin\alpha}{\sin\beta}\right]\bar{b}\,b\,H_0 +$$

$$+\left[\tg\beta\right] i\,\bar{b}\gamma_5 b\,A_0 +$$

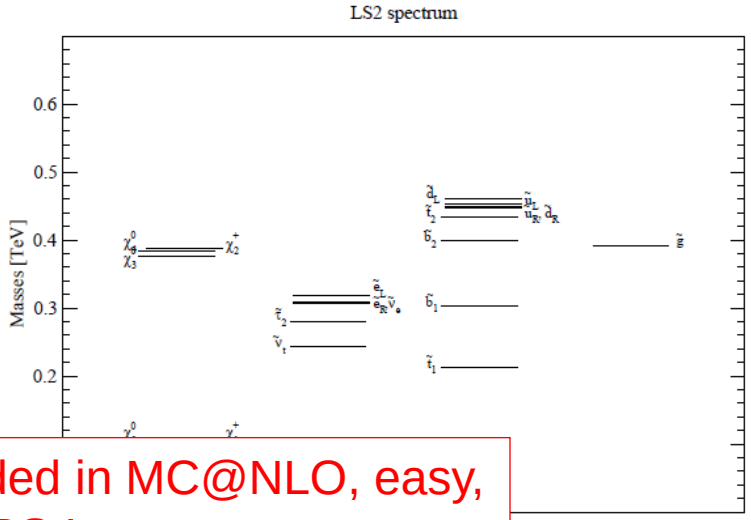
$$\left.+\left[\sqrt{2}\,\tg\beta\left(H^+\bar{t}_L b_R + H^-\bar{b}_R t_L\right)\right]\right.$$

where Q is the "typical" energy scale of the process ($\sim M_{H^-}+m_t$ or M_h) and $\overline{m}_b$ is computed in a safe renormalize. scheme (e.g. $\overline{DR}$).

(V_{tb} assumed to be 1 ....) (in $H^+ V_{tb}\,\bar{t}_L b_R$ ...)

Light MSSM spectrum LS2:

mSUGRA scenario	m_0	$m_{1/2}$	A_0	$\tan\beta$	sign μ	H^-	$\alpha_s(Q)$
LS2	300	150	-500	50	+	229.6	0.0965325

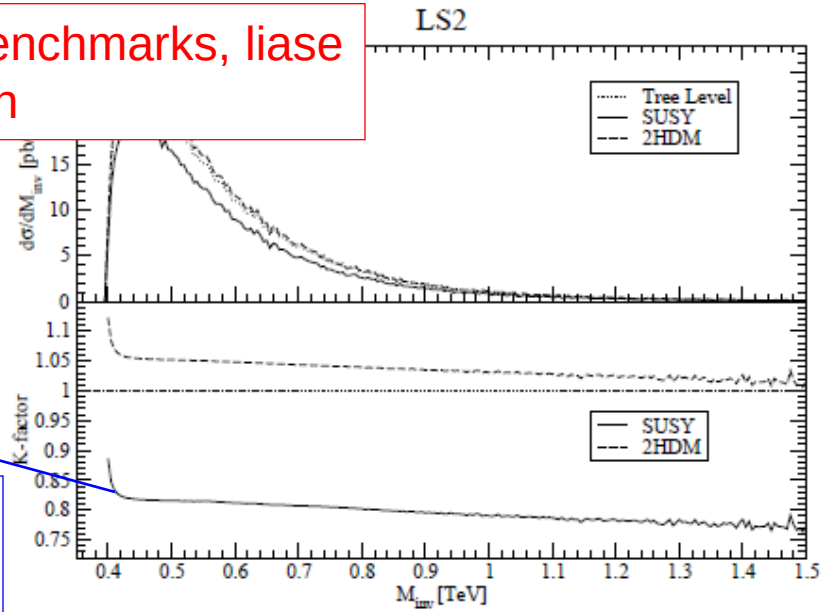


Note large tb !

Outlook: should be included in MC@NLO, easy, no double counting with PS !

Ditto re: MSSM benchmarks, liase with Ketevi & Sven

mSUGRA scenario	σ_{Born}	SUSY			
		σ_{1-loop}	K-factor	σ_{1-loop}	K-factor
LS2	5.589	4.545	0.813	5.867	1.050



Effects of -20% already at threshold, where cross section is maximal (is not the usual large Sudakov log(s))

Claudio's conclusions: democracy restored, MSSM EW effect competitive with MSSM QCD, and even SM QCD & EW !

HIGGSBOUNDS 2.0.0

Oliver Brein

HiggsBounds : tests models with arbitrary Higgs sectors against exclusion bounds from LEP/Tevatron Higgs searches.

- easy access to all relevant Higgs exclusion limits
  including information not available in the publications.
  (e.g. expected 95% CL cross section limits for some LEP combinations)

- applicable to models with arbitrary Higgs sectors (narrow widths assumed)
  HiggsBounds Input: the predictions of the model for:
  # of neutral & charged Higgs bosons h_i , m_{h_i}, $\Gamma_{\rm tot}(h_i)$, BR($h_i \to \ldots$),
  production cross section ratios (wrt reference values)

- combination of results from LEP and Tevatron possible

- three ways to use HiggsBounds:
  ☐ command line, ☐ subroutines (Fortran 77/90), ☐ web interface:
  www.ippp.dur.ac.uk/HiggsBounds

implemented analyses :

⋆ neutral Higgs, LEP [HiggsBounds 2.0.0]

$e^+e^- \to h_k Z, h_k \to bb$ or $h_k \to \tau\tau$ [LEP, EPJC46(2006)547)]

e^+ , EPJC 27(2003)311]

[..

⋆ 3ounds 2.0.0]

e^+ -ex/0107031],

e^+

e^+

i

HIGGSBOUNDS

⋆ neutral Higgs, Tevatron, single topology

$p\bar{p} \to Zh_k \to ll b\bar{b}$, CDF with 5.7 fb^{-1} [CDF note 10235]

$p\bar{p} \to Zh_k \to ll b\bar{b}$, D0 with 6.2 fb^{-1} [D0 note 6089]

$p\bar{p} \to Wh_k \to l\nu b\bar{b}$, D0 with 5.3 fb^{-1} [D0 note 6092] ar

[...] etc.

⋆ charged Higgs, Tevatron [HiggsBounds 2.0.0]

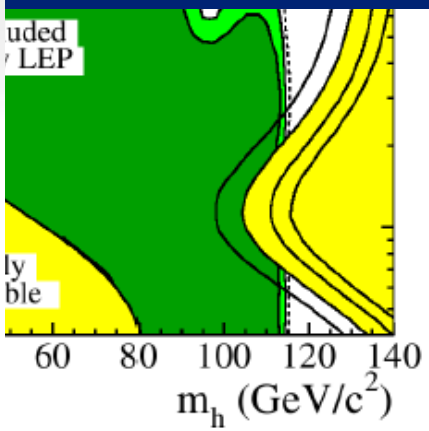
$p\bar{p} \to tt, t \to H + b(\&\ \text{c.c.}), H^+ \to cs$, D0 with 1.0 fb^{-1}

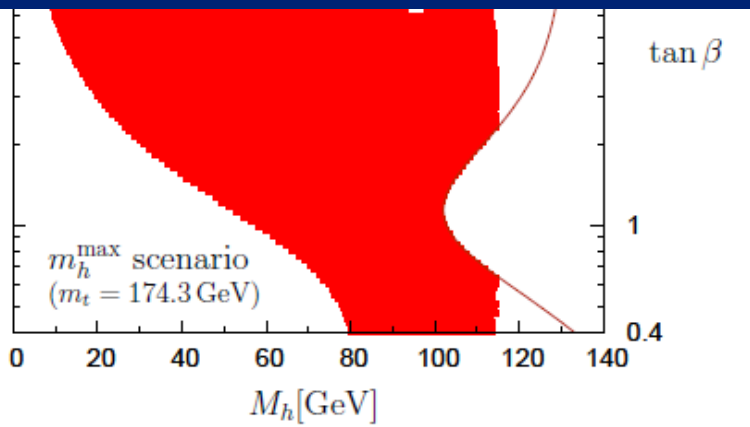
1.0 fb^{-1}

tion,

Program should not be trusted though !

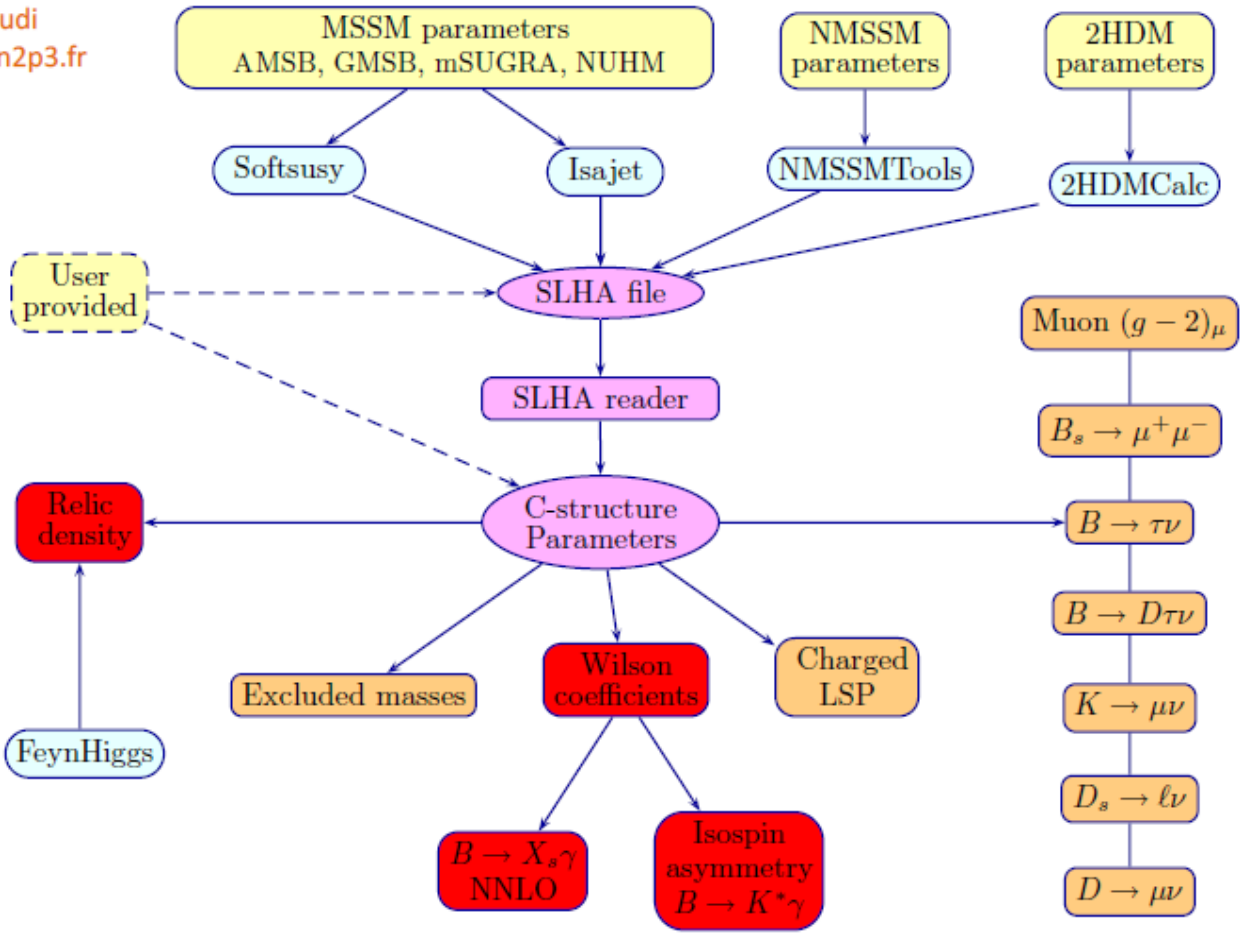
HOFBRÄU HB MÜNCHEN





Flavour contraints and SuperIso

F. Nazila Mahmoudi
http://superiso.in2p3.fr



Indirect Constraints

Flavour observables

1. Radiative penguin decays
2. Electroweak penguin decays
3. Neutrino modes
4. Meson mixings

Other observables

1. Anomalous magnetic moment of muon $a_\mu = (g-2)/2$
2. Relic density

Models

Standard Model

General Two Higgs Doublet Model

automatic interface with 2HDMC for

- General 2HDM and Types I, II, III, IV

MSSM (with Minimal Flavour Violation)

automatic interfaces with Softsusy, Isajet, Spheno and Suspect available for

- CMSSM, NUHM, AMSB, HC-AMSB, MM-AMSB, GMSB

NMSSM

automatic interface with NMSSMTools available for

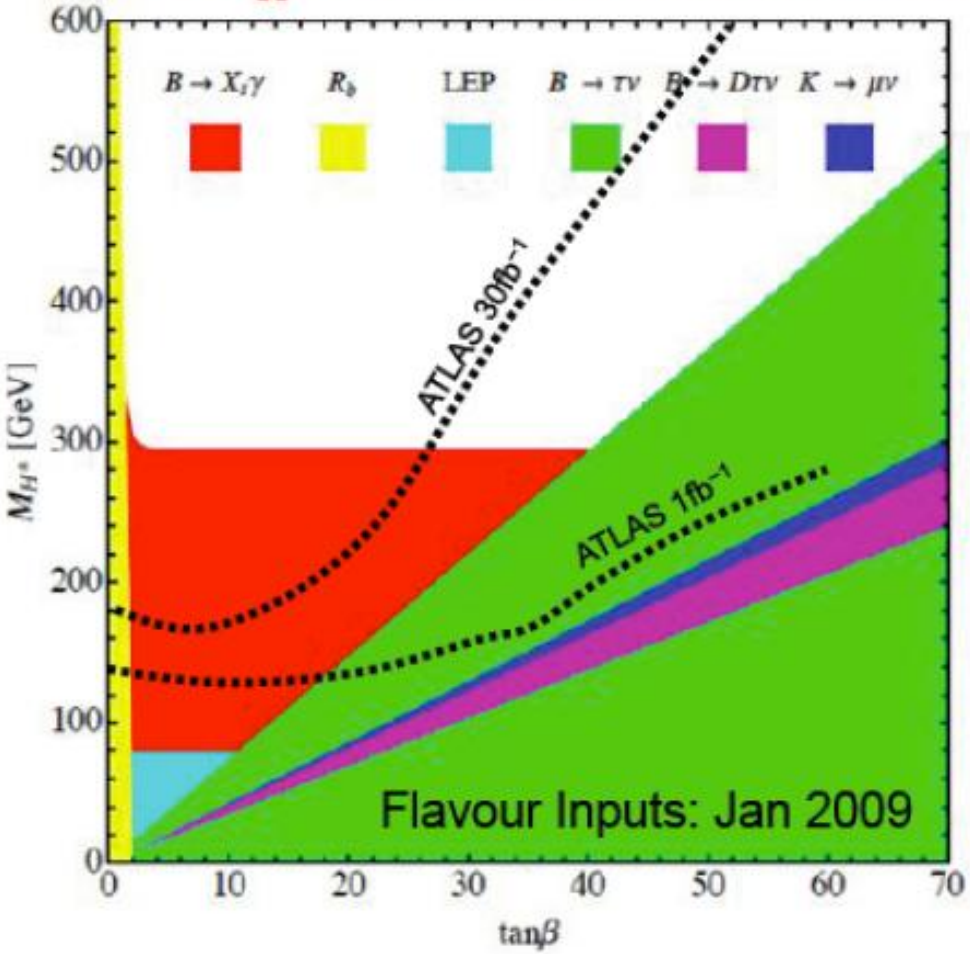
- CNMSSM, NNUHM, NGMSB

BMSSM

automatic interface with a modified version of Suspect

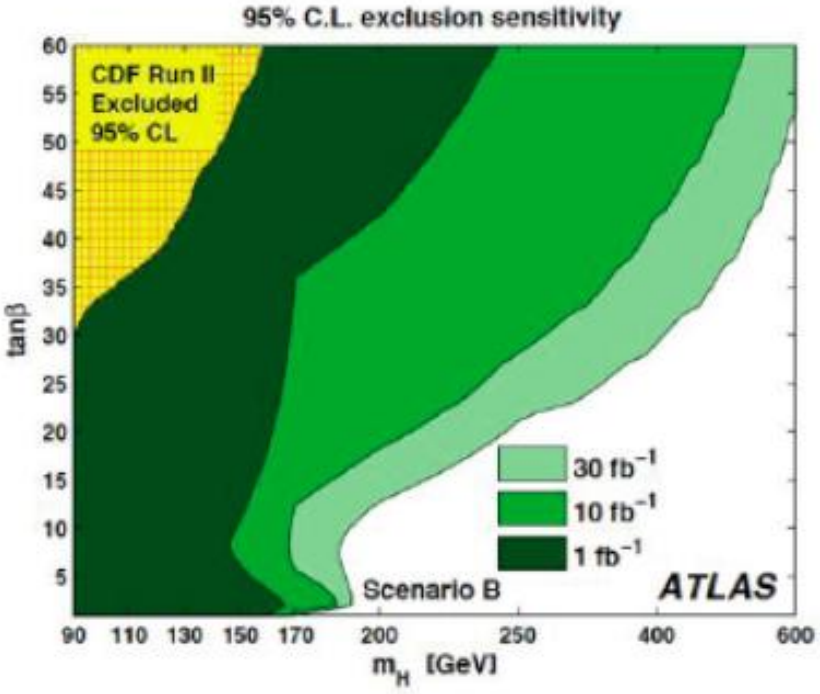
LHC versus Flavour constraints

Combined Higgs search constraint from ATLAS: arXiv:0901.1502



U. Haisch 0805.2141
2HDM

Converted constraints expected from ATLAS onto the plot by hand.



Courtesy of Adrian Bevan

Constraining the Charged Higgs Mass in the MSSM

A Low-Energy Approach

Christopher Kolda

Can the charged Higgs of the MSSM be "light"?

But that's not the whole story . . .

From LEP ($e^+e^- \to H^+H^-$): $m_{H^\pm} > 79\,\text{GeV}$.

Many other constraints on $H^\pm$, including:

- Correlations with SM-like neutral Higgs (h^0)
- $B \to \tau\nu$ and $B \to D\tau\nu$
- $B_s \to \mu\mu$

There are also constraints on the cancellation, through constraints on masses of squarks, winos and higgsinos.

Most of these highly model-dependent, *like the cancellation of the* $b \to s\gamma$ *contributions!*

The goals for this analysis:

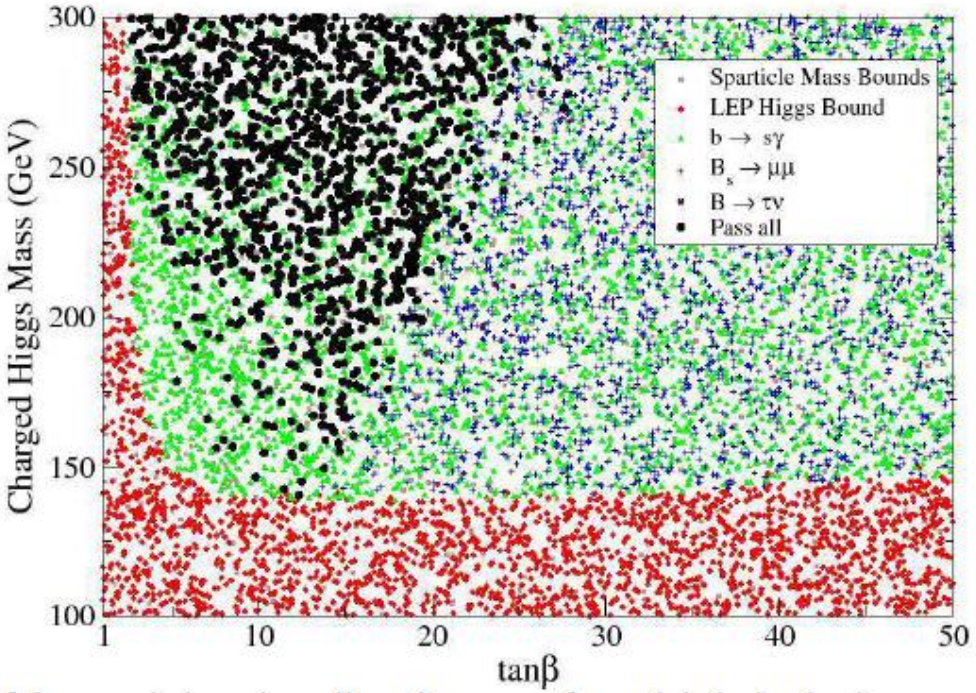
- Examine parameters space of minimal SUSY to find regions in which significant cancellation of $b \to s\gamma$ occurs.
- Find a lower bound on $H^{\pm}$ mass consistent with all constraints.
- Correlate the existence of a light $H^{\pm}$ with other SUSY observables.
- Do this analysis without embedding into mSUGRA, CMSSM or any other model for ultraviolet physics $\longrightarrow$ work from the bottom up!

We also impose:

- $m_{\chi_1^{\pm}} > 103\,\text{GeV}$
- $m_{\tilde{t}_1} > 95$
- Tevatron
- Bounds

This is a bottom-up analysis of the MSSM, not the CMSSM or some other UV model. All parameters are treated as parameters in an effective theory.

Results: Max Mixing



Low $m_{H^\pm}$ and low $\tan\beta$ excluded by LEP bound on light Higgs

$b \to s\gamma$ excludes points throughout parameter space, but is especially constraining for lighter $H^\pm$

$B \to \mu\mu$ turns on for $\tan\beta > 15 - 20$, killing all points which pass $b \to s\gamma$ constraint

Max-mixing implies larger A_t, which help in cancellation of $b \to s\gamma$ but also generate large $B \to \mu\mu$.

If a charged Higgs is found at LHC below 300 GeV we should expect a lot more!

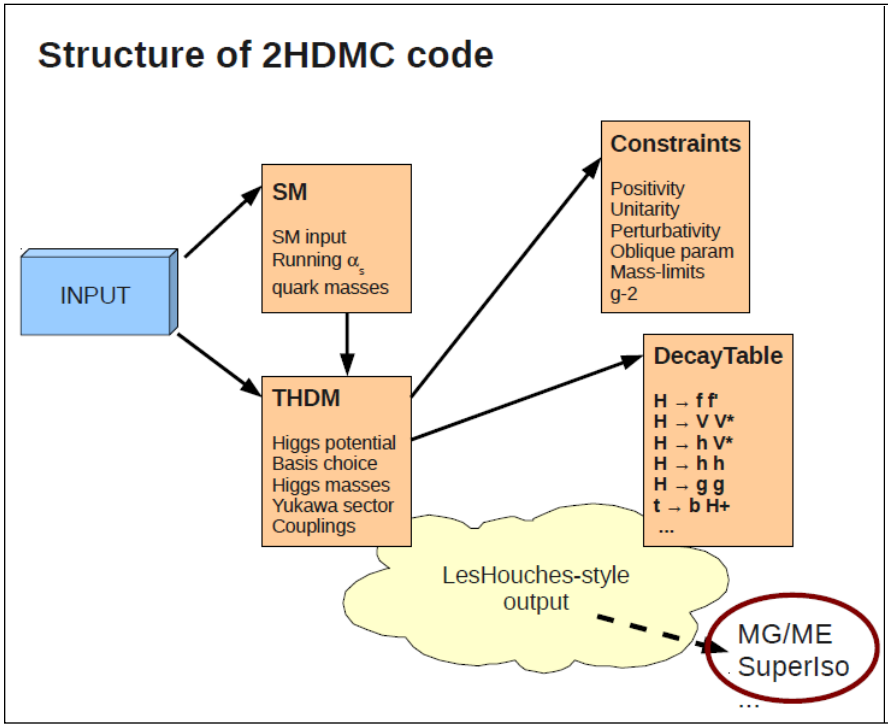
Yet one more reason to go beyond the heavy sparticle limit of the xMSSM: x -> any

2HDMC: two Higgs doublet model calculator

D. Eriksson, J. Rathsman, OS
http://www.isv.uu.se/thep/MC/2HDMC

Public version: 1.1 (2010-09-28)

- General (CP-conserving) 2HDM
- Different 2HDM parametrizations
- Tree-level spectrum calculation
- Arbitrary Yukawa sector or Z_2-"types", aligned model, etc.
- Theoretical constraints (positivity, unitarity)
- Collider mass limits (HiggsBounds 2.0, Charged Higgs)
- Oblique EW parameters, muon g-2
- All two-body Higgs decays at tree-level (incl. FCNC)
- Leading QCD corrections
- Non-standard top decays
- H → VV* and H → HV* off-shell decays
- H → gg and H → gg
- Model file for MG/ME to generate events
- LesHouches-style interface (SuperIso, MG/ME, ...)

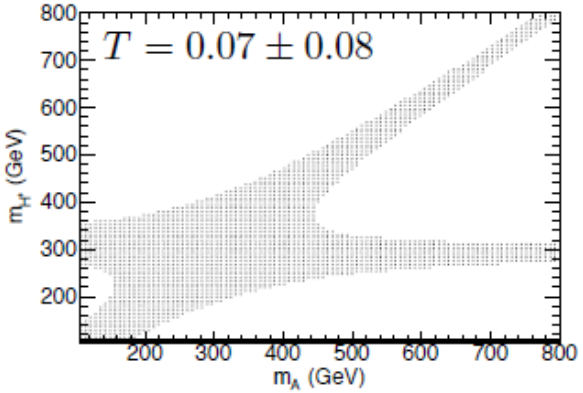


2HDMC: Examples

- Mass constraints from T parameter

$m_h = 117$ GeV

$m_H = 300$ GeV $\quad \sin(\beta - \alpha) = 1$



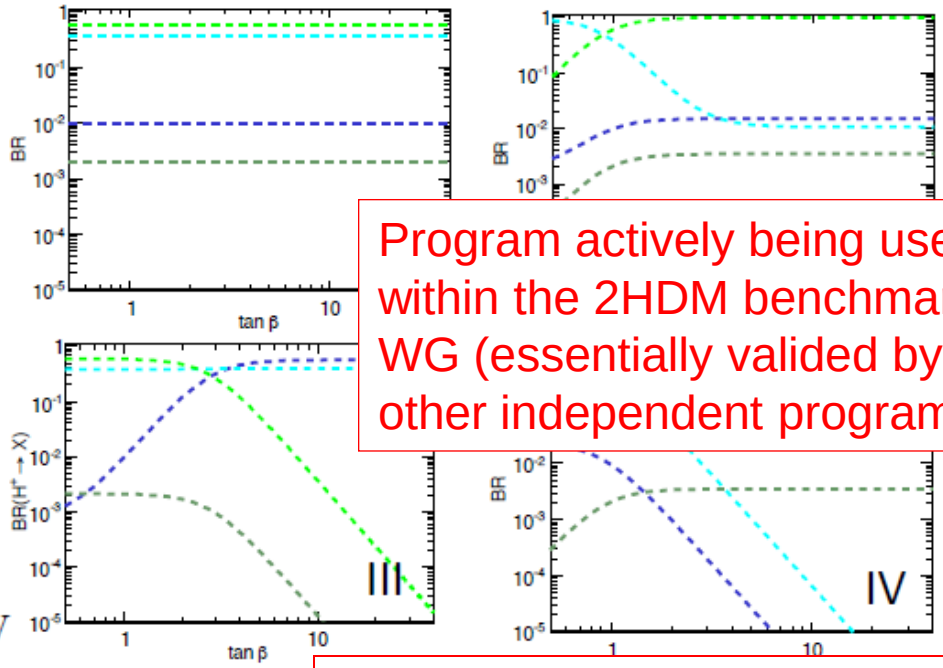
- H+ decays in 2HDM types

$H^+ \to c\bar{b}$

$H^+ \to c\bar{s}$

$H^+ \to \tau^+\nu_\tau$

$H^+ \to \mu^+\nu_\mu$



$m_H = m_A = m_{H^+} = 150\,\text{GeV}$

Program actively being used within the 2HDM benchmark WG (essentially valided by two other independent programs)

Can it be upgraded to CPV (to sit on a par of CPV MSSM codes like FeynHiggs, CPSuperH): CPV one of the charges of the 2HDM WG

Higher-order corrections to $M_{H^\pm}$

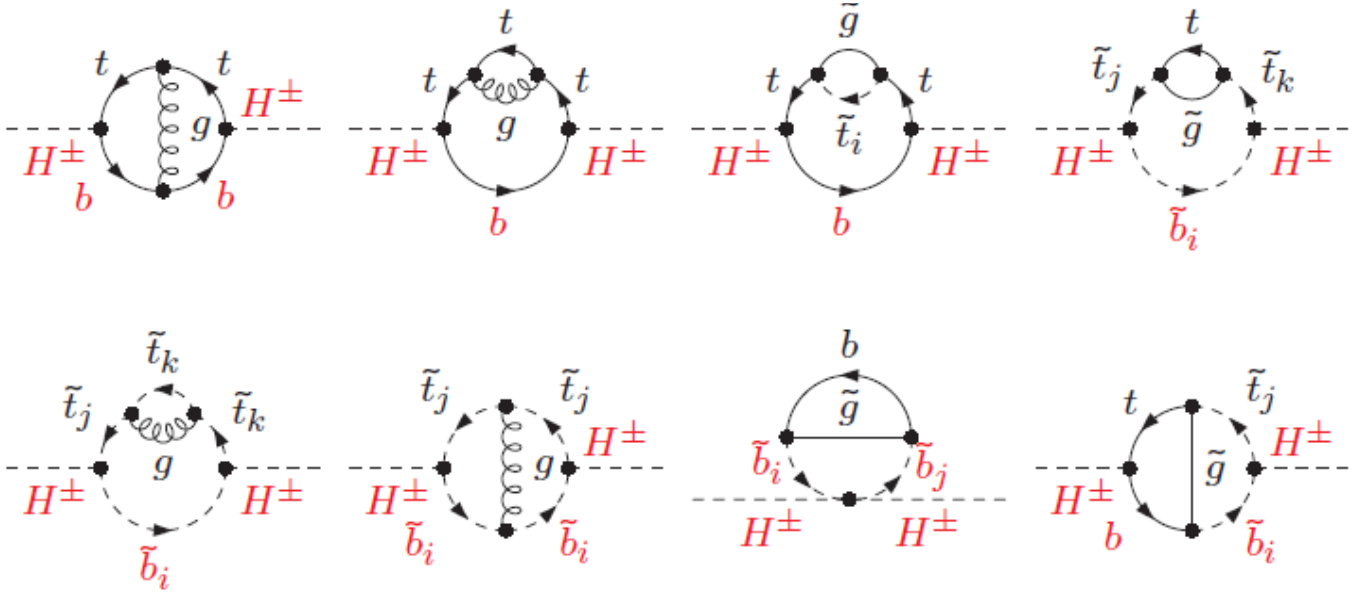
In lowest order:

$$m^2_{H^\pm} = M_A^2 + M_W^2$$

Keep in mind: higher-order corrections

$\Rightarrow$ Test of the model!

2-loop self-energy diagrams:



new: $H^\pm$ as external Higgs

$\Rightarrow$ $b/\tilde{b}$ enter (even diagrams without $t/\tilde{t}$: $H^+H^-\tilde{b}_i\tilde{b}_j \sim y_t^2$)

$\Rightarrow$ renormalization of $b/\tilde{b}$ sector necessary

Numerical results:

→ $m_h^{\max}$ scenario, with variation of

- M_A : tree-level parameter
- $\tan\beta$: tree-level parameter
- μ : enters via Δ_b

(no-mixing scenario similar)

Experimental resolution:

$M_{H^\pm} = 200$ GeV:

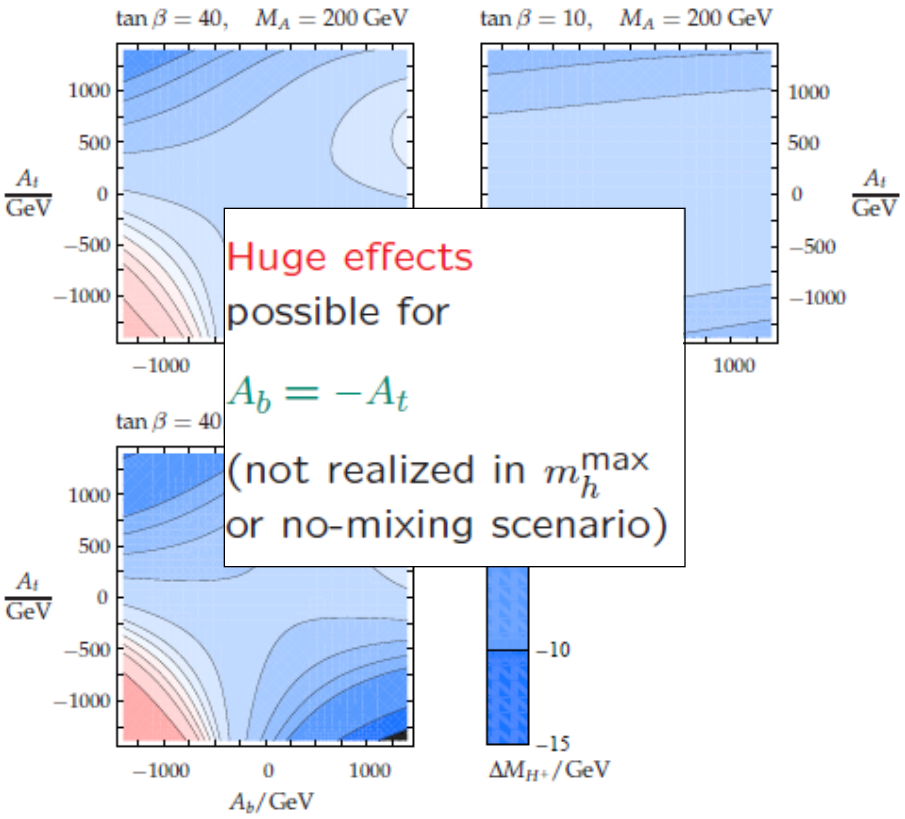
LHC : $\Rightarrow \delta M_{H^\pm} \approx 1.5$ GeV

ILC : $\Rightarrow \delta M_{H^\pm} \approx 0.5$ GeV

Higher masses:

LHC : $\Rightarrow \delta M_{H^\pm} \approx 1 - 2\%$

full 1-loop, A_t–A_b plane, $\mu = 1000$ GeV:

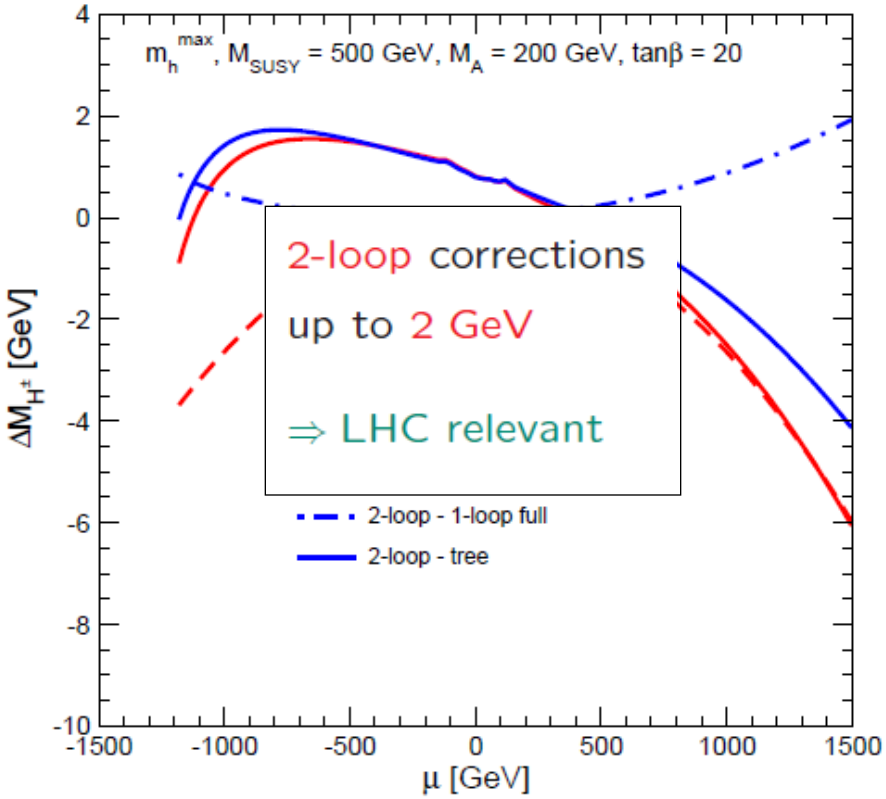


Huge effects possible for

$A_b = -A_t$

(not realized in $m_h^{\max}$ or no-mixing scenario)

2-loop $\mathcal{O}(\alpha_t\alpha_s)$, $\tan\beta = 20$, μ varied:



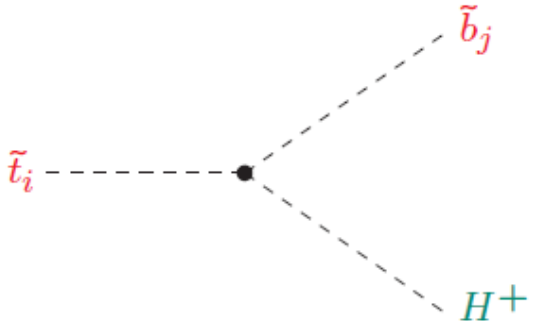
2-loop corrections up to 2 GeV

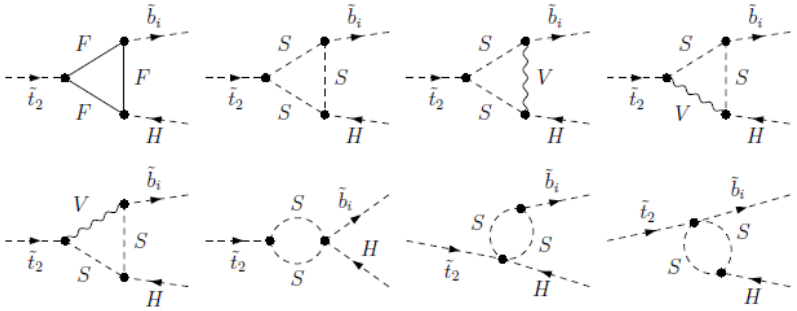
$\Rightarrow$ LHC relevant

Higher-order corrections to $\tilde{t}_i \to \tilde{b}_j H^+$

Sven Heinemeyer

Decay of $\tilde{t}_i \to \tilde{b}_j H^+$:





- important decay modes of stops
- A_t and A_b directly enter the vertex
- source of charged Higgs bosons in SUSY cascades at the LHC

$\Rightarrow$ higher-order corrections important!

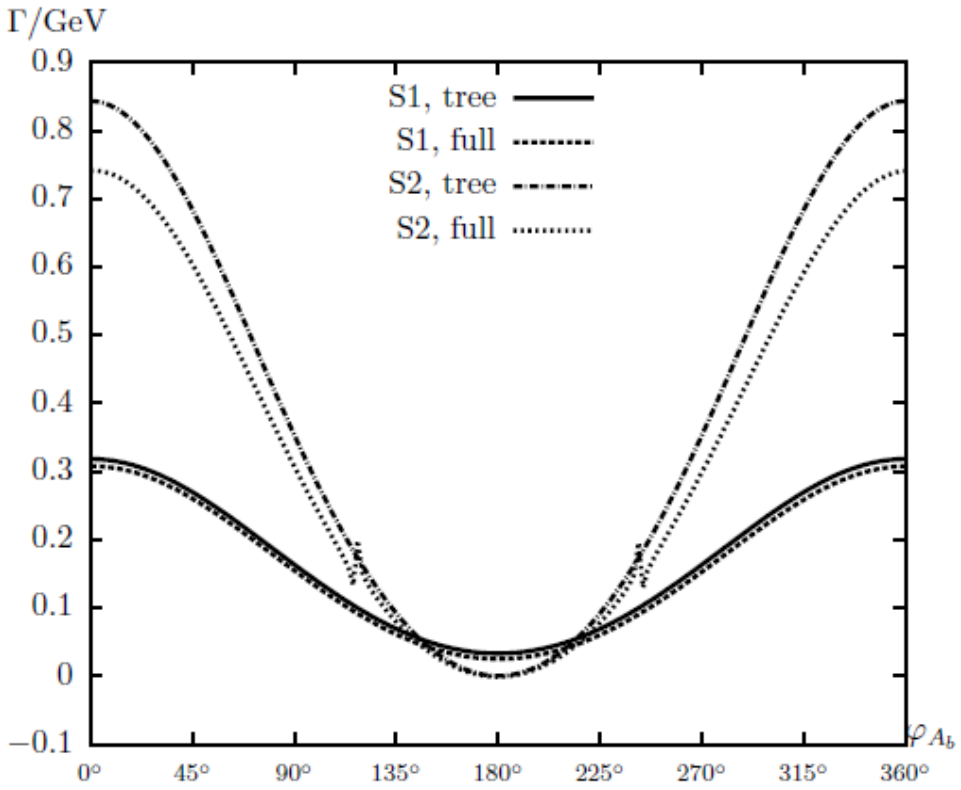
$\Rightarrow$ simultaneous renormalization of stop and sbottom sector required!

$\Rightarrow$ including complex phases!

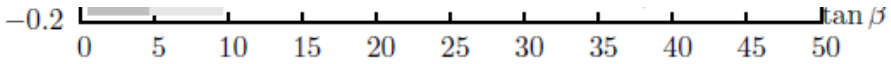
Scen.	$\tan\beta$	$m_{\tilde{t}_1}$	$m_{\tilde{t}_2}$	$m_{\tilde{b}_1}$	$m_{\tilde{b}_2}$
	2	293.391	600.000	441.987	447.168
					.226
					.638
					.598
					.180
					.202

$\Gamma(\tilde{t}_2 \to \tilde{b}_1 H^+)$: dependence on ϕ_{A_b} ($\tan\beta = 20$)

$\Gamma(\tilde{t}_2 \to$



⇒ one-loop corrections under control except of sharp peaks at $|U_{\tilde{b}_{11}}| \approx |U_{\tilde{b}_{12}}|$



⇒ one-loop corrections under control for all $\tan\beta$ values, up to $\sim 25\%$

SUSY conclusions ?

4. Conclusinos

- Charged MSSM Higgs boson:

  mass and couplings predicted in terms of other model p
  ⇒ test of the model, parameter determination
  ⇒ needed for reliable prediction of phenomenology

- Higher-order corrections to $M_{H^\pm}$:
  - 1L: all sectors relevant ⇒ full 1L necessary
    Δ_b corrections crucial
  - 2L $\mathcal{O}(\alpha_t\alpha_s)$: $\Delta M_{H^\pm} = 0.5 - 2$ GeV
    important for LHC/ILC precision

  ⇒ included in FeynHiggs

- Higher-order corrections to $\tilde{t}_i \to \tilde{b}_j H^+$:
  - many possible ways (renormalizations) for higher-order corrections
  - most "robust": RS2: "m_b, A_b $\overline{\text{DR}}$" ← preferred scheme
  - 1L corrections under control, up to ~ 25%

  ⇒ will be included in FeynHiggs

?

?

Can be turn around, H+ -> stop sbottom also stable

Effects fed into FeynHiggs, hence naturally included in the H->SUSY & SUSY-> Higgs exercises of the MSSM Benchmarks WGs

Summary of tools for charged Higgs

Task / Model	2HDM	rMSSM	cMSSM	NMSSM
Spectrum	2HDMC	SoftSUSY Spheno FeynHiggs	CPSuperH FeynHiggs	NMSSMTools
Decays	2HDMC	FeynHiggs HDecay	CPSuperH FeynHiggs	NMSSMTools
Cross sections	(MC@NLO) (Prospino)	MC@NLO FeynHiggs Prospino	MC@NLO FeynHiggs Prospino	(MC@NLO) (Prospino)
Collider limits	HiggsBounds (2HDMC)	HiggsBounds	HiggsBounds	HiggsBounds NMSSMTools
Flavor physics	SuperIso	SuperIso SUSYBsg FeynHiggs	CPSuperH	SuperIso
Event generation	MG/ME (MC@NLO)	MC@NLO	MC@NLO	(MC@NLO) WHIZARD

Also recall standard MCs: HERWIG, PYTHIA, SHERPA, ISAJET

Plus LanHEP/FeynRules feed to CalcHEP/MadEvent/LoopToos/etc.

Final words, requests

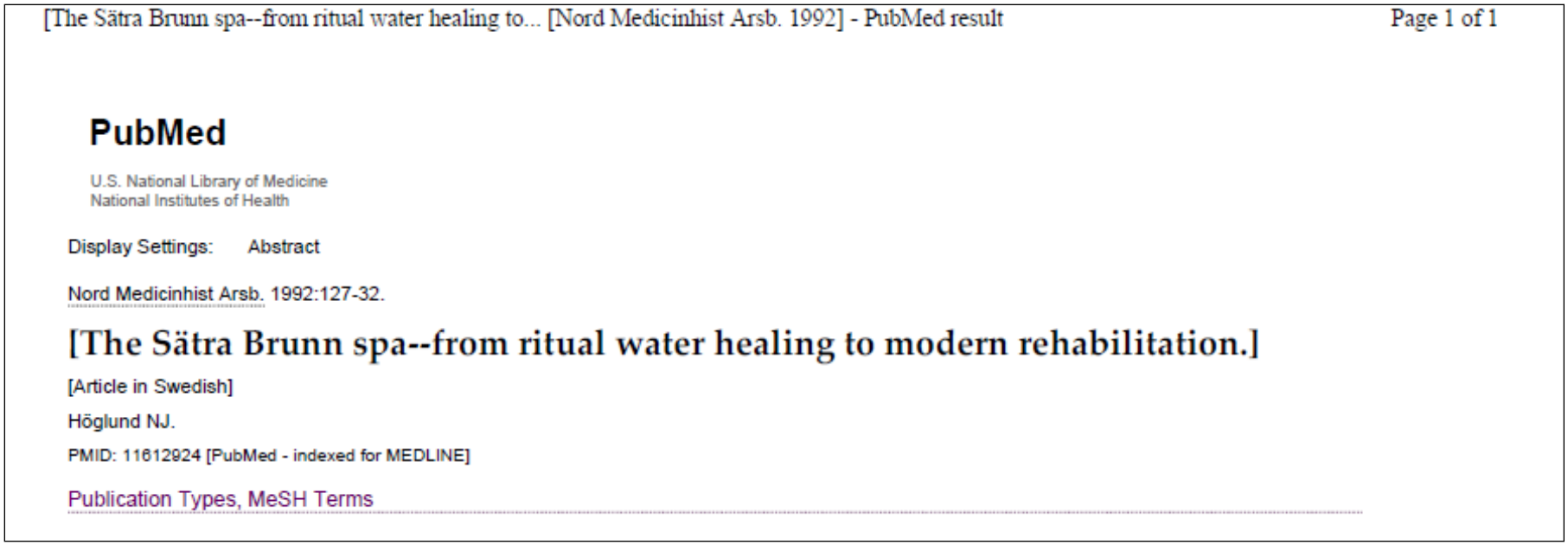
- Development of tools for charged Higgs physics has prospered since the previous workshop in 2008.

- Major achievements:
  - MC@NLO for H^+t production
  - HiggsBounds for model independent collider limits
  - 2HDMC for phenomenology in general 2HDM
  - Continuous updates and improvements to most other codes

- The pheno community is well-equipped with tools to meet the LHC data, and there might be still some time for improvements.

- What else would you have us do?

Conclusions and general outlook



[The Sätra Brunn spa--from ritual water healing to... [Nord Medicinhist Arsb. 1992] - PubMed result Page 1 of 1

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Display Settings: Abstract

Nord Medicinhist Arsb. 1992:127-32.

[The Sätra Brunn spa--from ritual water healing to modern rehabilitation.]

[Article in Swedish]

Höglund NJ.

PMID: 11612924 [PubMed - indexed for MEDLINE]

Publication Types, MeSH Terms

Thanks to all the speakers and organisers for a very enjoyable workshop !

PS: well water completely altered body fluid balance in many bodies, Tord forgot mentioning its `well established' diuretic properties …