Higgs production in the 1 TeV domain: logarithmic Sudakov expansion and $\tan\beta$ measurement analysis.

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Calculating the scattering amplitude of the process

$$e^+e^- \longrightarrow H^+H^-,\ \ H^0A^0,\ \ h^0A^0$$

- MSSM framework
- Analytical calculations at 1 loop level in perturbation theory
- Center of mass energy of about 1 TeV
- Asymptotic Sudakov approach in *light* SUSY parameter scenario

for the H^+H^- case we have a complete C++ code for numerical analyses
(we are preparing the same code for H^0A^0, h^0A^0)

Asymptotic Sudakov expansion

Light SUSY parameters: all mass parameters $\lesssim 400\ GeV$

Example of asymptotic structure of an observable:

$$\sigma \simeq \sum_i a_i \log^2 \frac{q^2}{M_{ai}^2} + \sum_i b_i \log \frac{q^2}{M_{bi}^2} + c$$

$$\text{analytically known} \begin{cases} a_i & : \text{ no SUSY parameters} \\ b_i & : \tan\beta,\ \alpha \text{ from Yukawa interactions} \end{cases}$$

analytically unknown c : all SUSY parameters

$\Rightarrow$ validity of Sudakov expansion for $\sqrt{q^2} \simeq 0.8 - 1.0\ TeV$
$\Rightarrow$ sensitivity of this process to MSSM effects
$\Rightarrow$ measurement of $\tan\beta$

(the H^+H^- case is analyzed in detail: hep-ph/0212167, submitted to Phys.Rev.D; 3^{rd} ECFA-DESY LC Workshop, Prague, 15^{th}-18^{th} November 2002)

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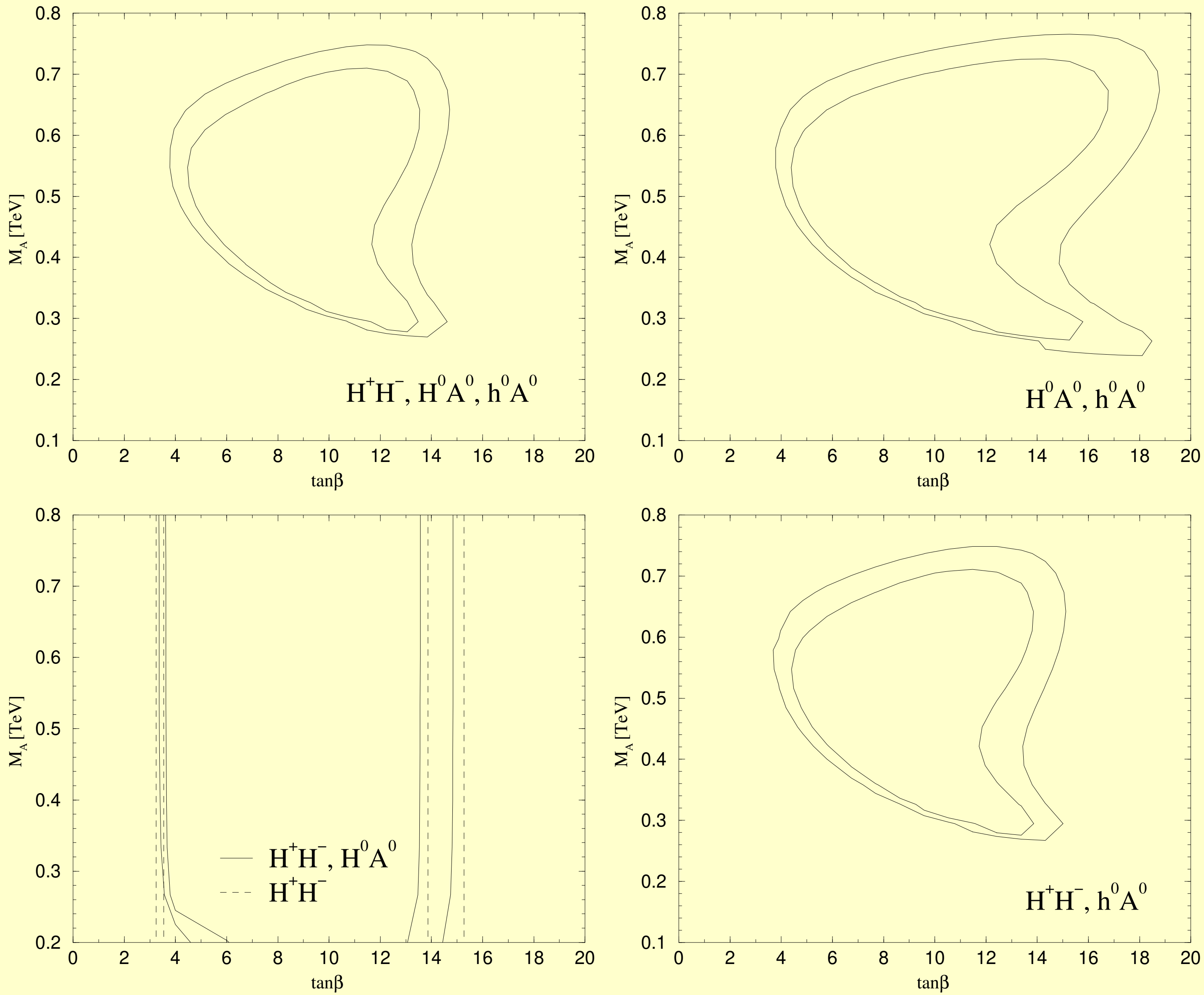
χ^2 *analysis*

$$\chi^2(\alpha, \tan\beta; \alpha^*, \tan\beta^*) = \frac{[\sigma(\alpha, \tan\beta) - \sigma(\alpha^*, \tan\beta^*)]^2}{\delta\sigma^2} \quad ; \quad \frac{\delta\sigma}{\sigma} = \frac{1}{\sqrt{L\sigma}}$$

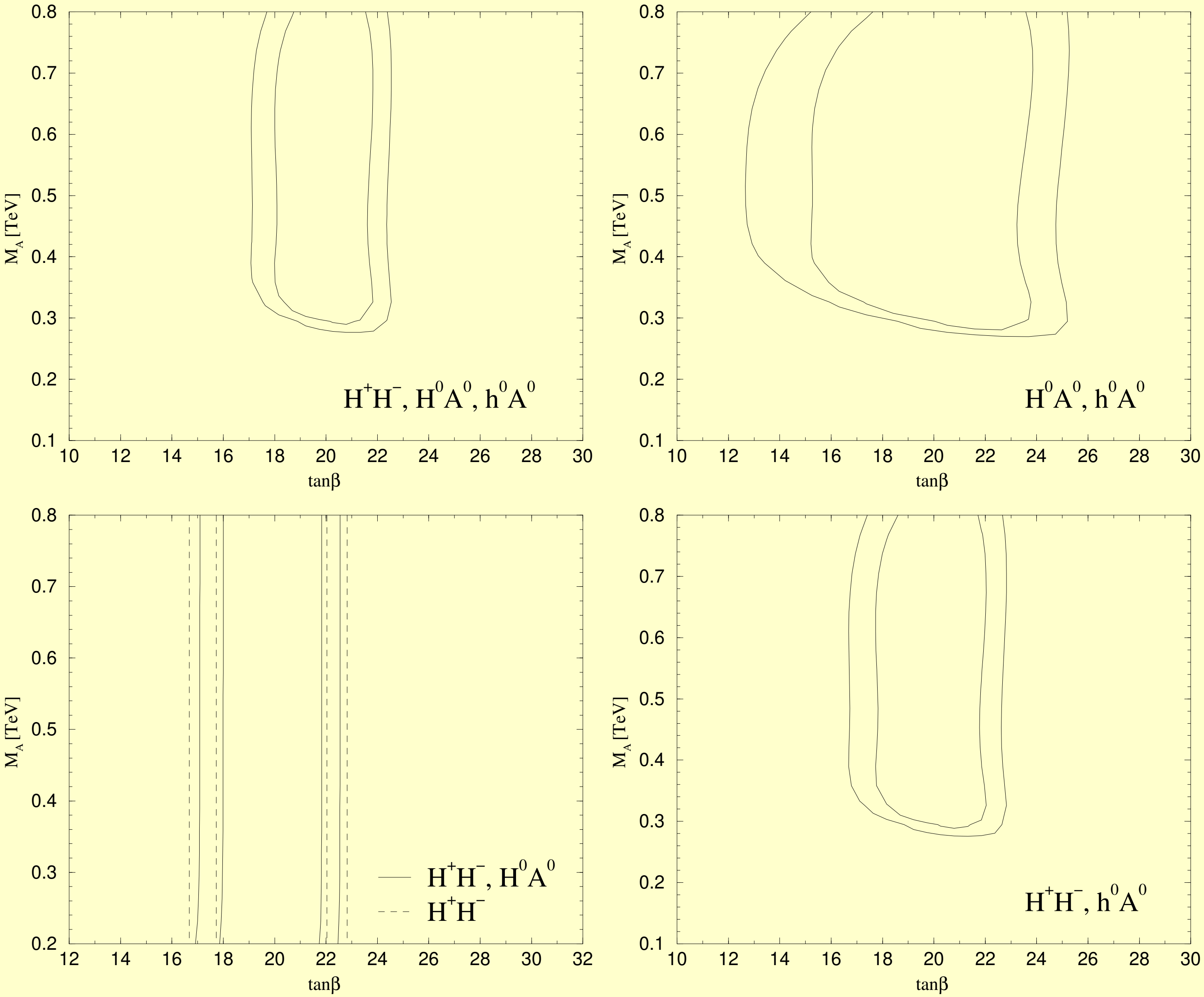
- contribution to σ from Yukawa terms
- 10 hypotetical measurements in the energy range 0.8-1.0 TeV
- Luminosity L such that the relative error on $\sigma(H^+H^-)$ is 1%
- using the code *FeynHiggsFast* by S.Heinemeyer, W.Hollik, G.Weiglein
  we calculated α as a function of M_A (fixing μ, M_1, M_2, A_u, A_d)
- $\tan\beta$ error estimate: $\frac{\delta\tan\beta}{\tan\beta^*} = \frac{|\tan\beta - \tan\beta^*|}{\tan\beta^*}$

  for each $\tan\beta^*$, $\tan\beta$ is such that $\chi^2(\tan\beta, \tan\beta^*)$ corresponds to 68%, 90% CL
  (... waiting for our numerical code for the H^0A^0, h^0A^0 case which provides a better $\tan\beta$ error estimate)
- analysis for fixed parameters:
  $M_A = 350\ GeV$, $\mu = 400\ GeV$, $M_1 = 200\ GeV$, $M_2 = 400\ GeV$, $A_u = 0$, $A_d = 0$

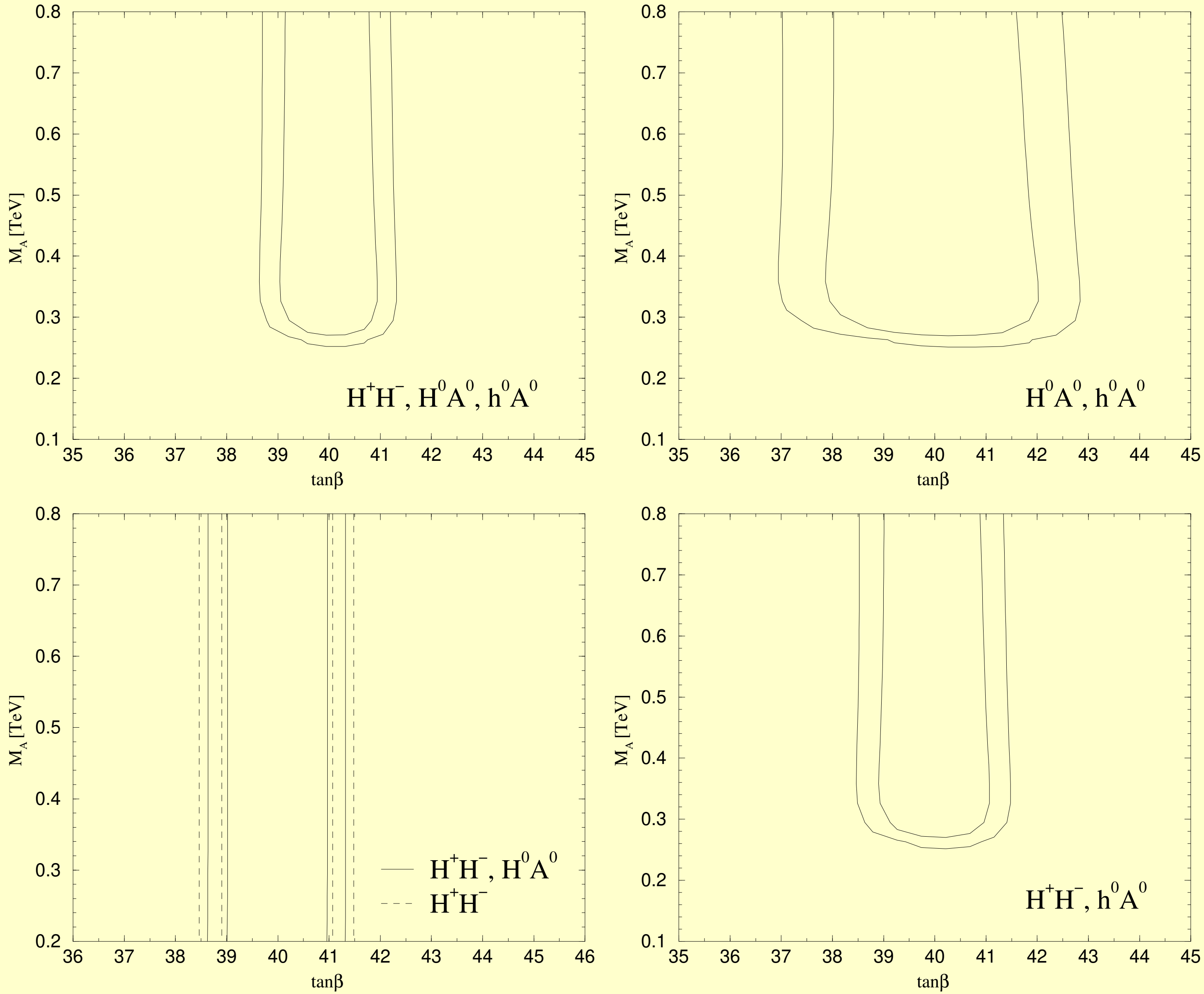
$\tan\beta = 10$, $M_A = 350\ GeV$: χ^2 *contour plots 68%, 90% CL*



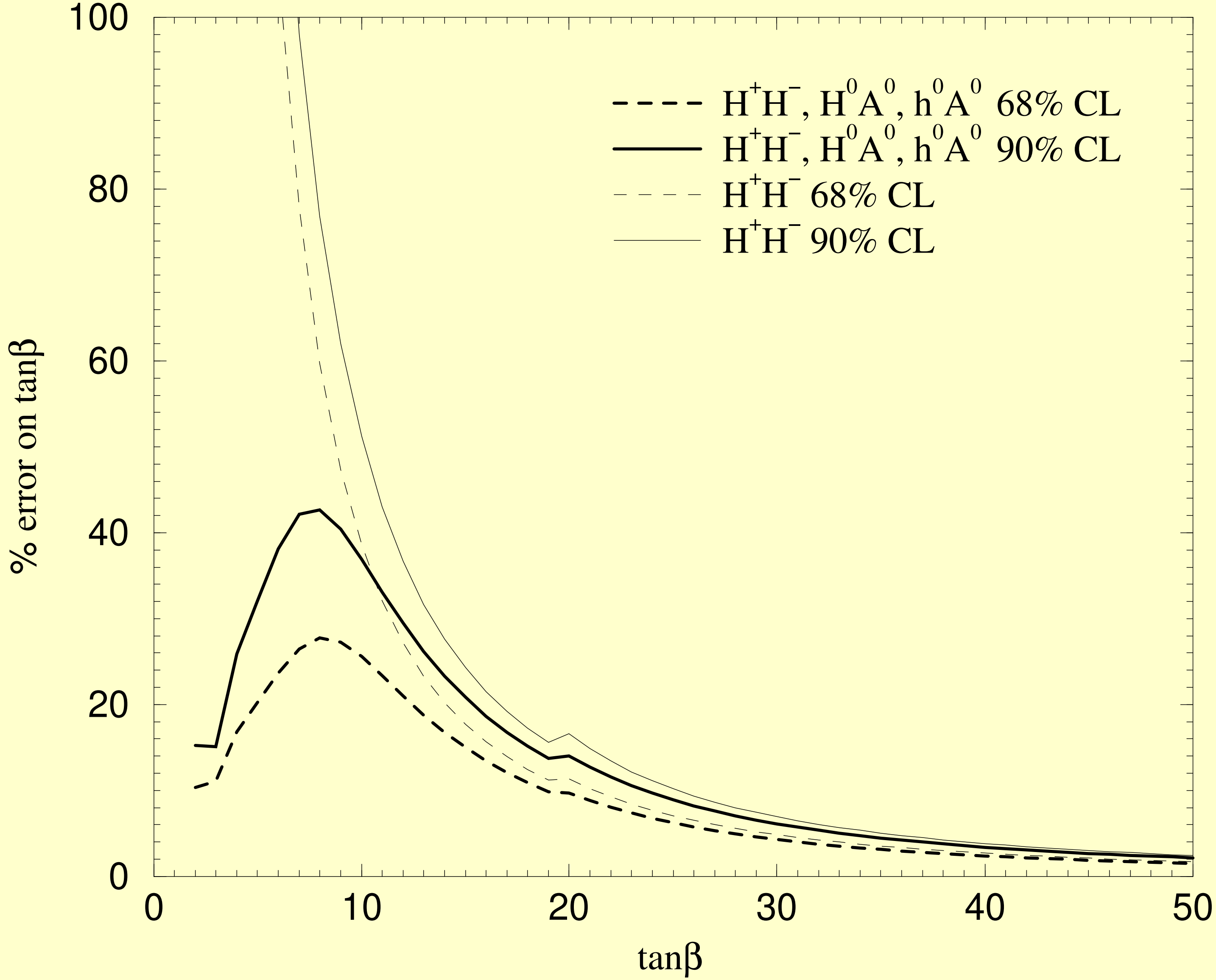
$\tan\beta = 20$, $M_A = 350\ GeV$: χ^2 contour plots 68%, 90% CL



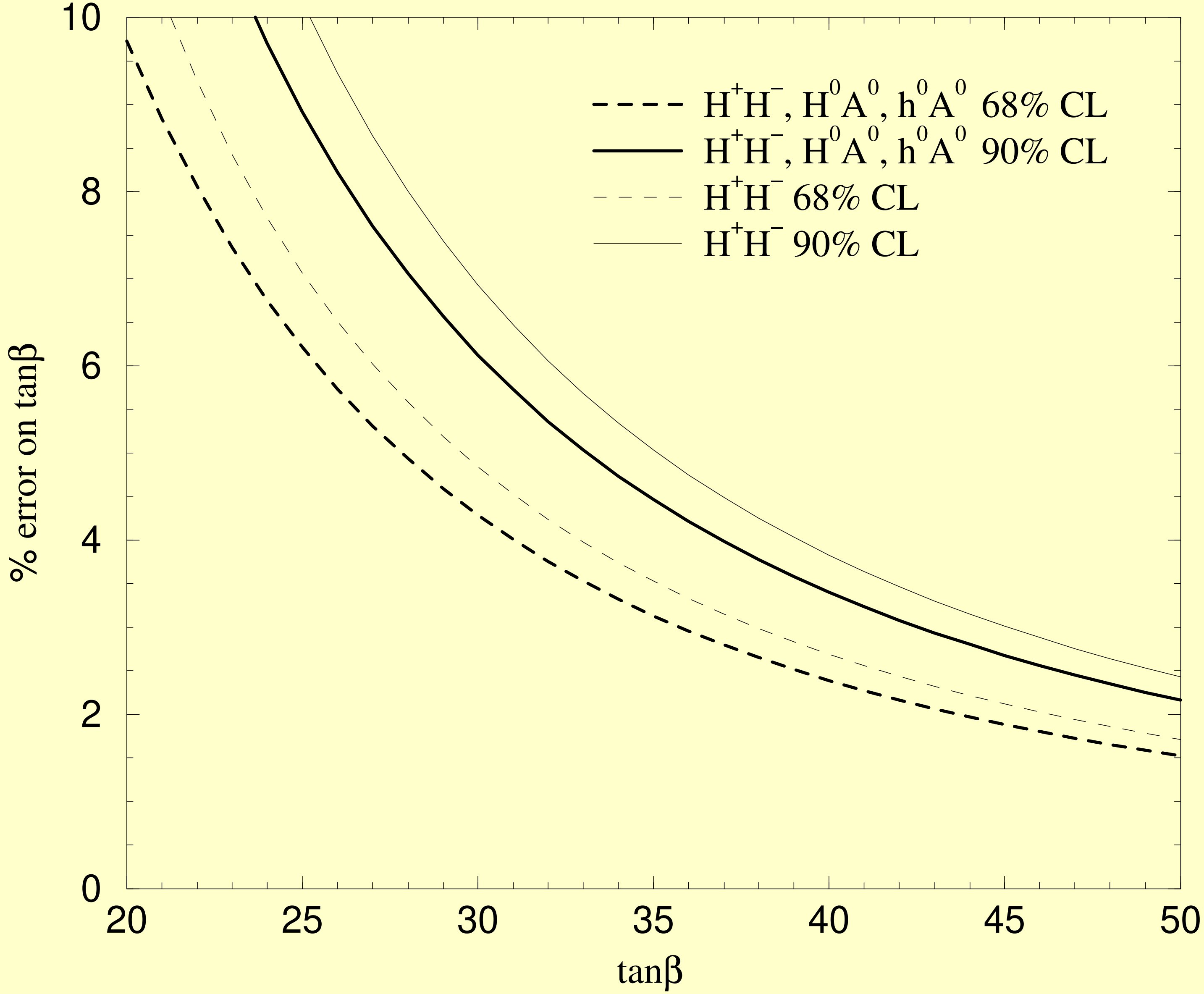
$\tan\beta = 40$, $M_A = 350\ GeV$: χ^2 contour plots 68%, 90% CL



$\tan\beta$ *error analysis*



$\tan\beta$ *error analysis*



Conclusions

$$e^+e^- \longrightarrow H^+H^-,\ \ H^0A^0,\ \ h^0A^0$$

- $\tan\beta \lesssim 10$: for accurate $\tan\beta$ measurements this process is probably not competitive with other techniques.
  Nevertheless it can always offer a consistency test.
- $\tan\beta \gtrsim 10$: to choose only charged or both charged and neutral higgs is equivalent for $\tan\beta$ measurements, at the assumed experimental accuracy.
- Only in the case of a drastic reduction of the experimental error in H^0 production, the combination of charged and neutral higgs will be useful to improve the error on $\tan\beta$ in the large ($\gtrsim 30$) range.

BUT: neutral higgs is also useful for other matter!

We are preparing a complete (also non-asymptotic) numerical analysis of the neutral case in order to show the behaviour of the relevant Sudakov coefficients, in particular:

$\Rightarrow$ numerical size and dependence on SUSY parameters
of next-to subleading (energy independent) terms

WORK IN PROGRESS...