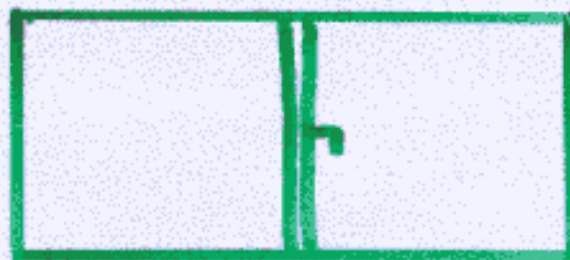


DESY LC meeting
September 2000

The light Higgs



in 2HDM

at GigaZ

P. Mättig
J. Zochowski
M. Krauss
(hep-ph/0009201)

MSSM

→ Higgs sector + supersymmetric particles

→ only 2 parameters independent at tree level (Supersymmetry relation $g \neq \lambda$)
eg. $\tan\beta, M_A$

prediction: $M_h \leq 135 \text{ GeV}$

data:

$M_h, M_A > 90 \text{ GeV}$

2HDM (II)

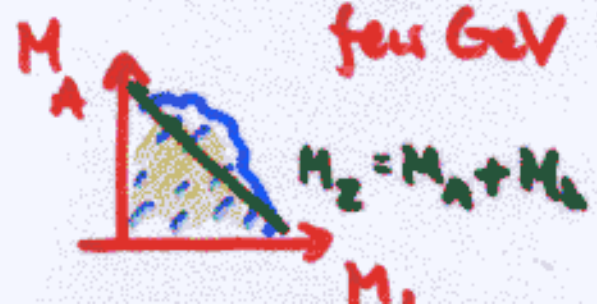
→ formal structure of Higgs sector as in MSSM

→ no relation between parameters

data:

even very light h or A may exist

↓
few GeV

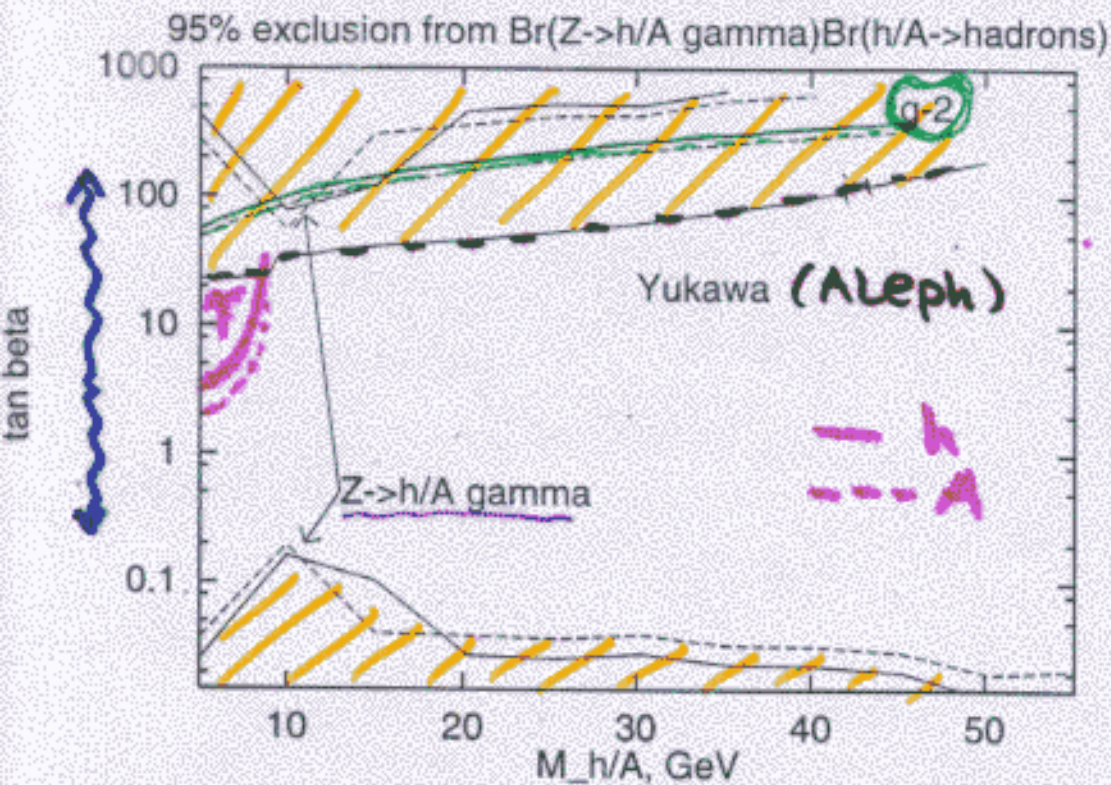


$g=2$

$\frac{L}{E} \Big| \begin{matrix} \text{Yukawa process} \\ Z \rightarrow h/A \gamma \end{matrix} + \text{global fit}$

HERA, $\gamma\gamma$ colliders...

2HDM Present limits on h(A)



LEP

$+ (g-2)$ Zochowski
MK PRD55

$+ \tau \rightarrow h(A) \gamma$
Keh'

$Z \rightarrow h/A \gamma$

Mattig, Zodyas
MK, EPJ.C99

The general 2HDM (II)

with CP conv.

- direct searches at LEP

h OR A → may be very light!
+ + (mass $\lesssim 40$ GeV)
(heavier H, A, H^\pm) (lighter h, H, H^\pm)
large $\tan\beta$ allowed!

$$M_{H^\pm} \gtrsim 80 \text{ GeV} \quad (\text{from } b \rightarrow s \gamma)$$
$$M_{H^\pm} \gtrsim 200 \text{ GeV}$$

- global fit to EW precision data for very light

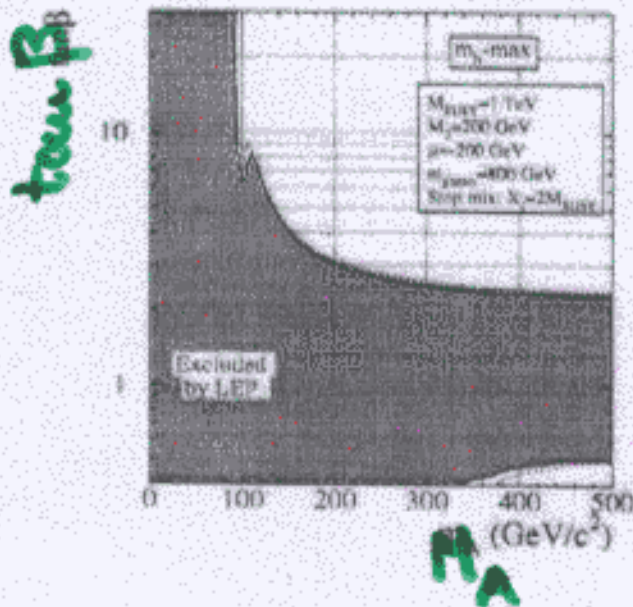
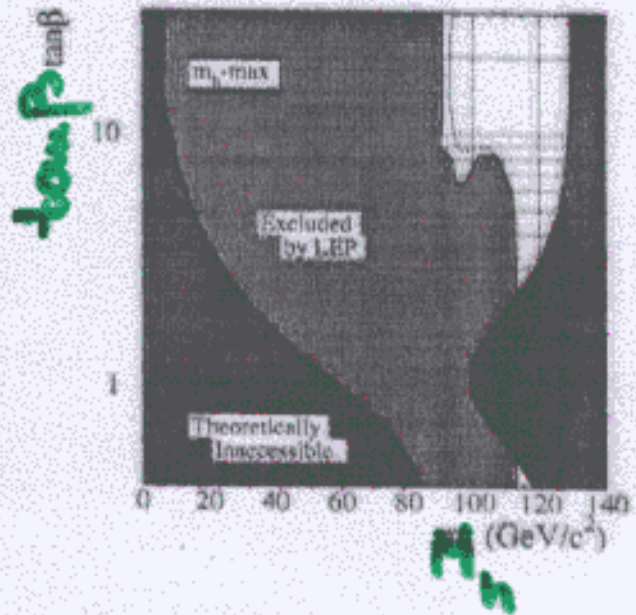
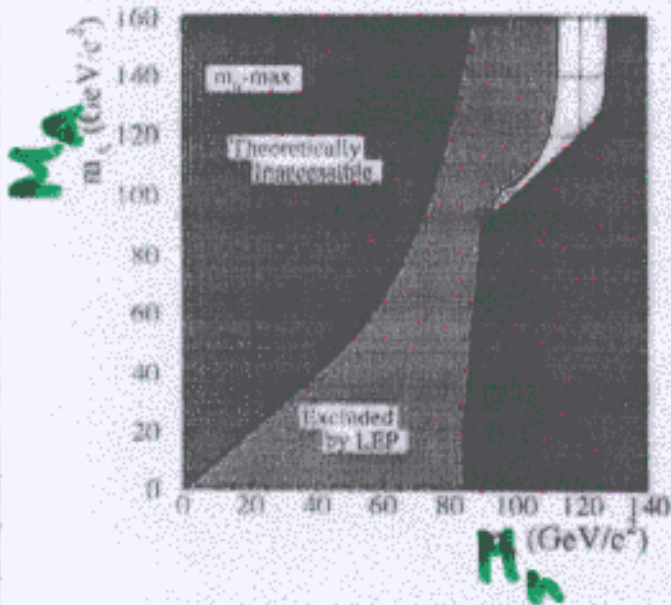
h
OR
 A } as good as for SM

Chankowski, Zoehwanski, Nucl. Phys. B 544 (1999) 241
E.P.J.C 44 (99) 664

in contrast to MSSM

(... MSSM Higgs)

LEP-combined results ... Max- m_h scenario



Mass limits at 95% CL ... $M_h, m_A > 90.5$ GeV (any mixing)

Exclusion in $\tan \beta$... 0.5 - \approx 2.3 ($m_{top} = 175$ GeV)

0.7 - 1.9 (- " - 180 GeV)

$M_{H^\pm} > 77.5$ GeV

P. Igo-Kemenes - New Physics (e^+e^- colliders) - ICHEP'2000

2HDM(III) + MSSM

Physics impact at GigaZ

hep-ph/0005024

J. Erler

S. Heinemeyer

N. Hollik

G. Weiglein

P.M. Zerwas

Running TESLA at Z resonance

→ 10^9 Z events / y

$\sim 7 \cdot 10^{22} \text{ e}^+ \text{e}^-$

precision measurements

↳ impact on parameters of SM, MSSM

The light Higgs in 2HDM (II) ↓ at Giga Z

also works
in progress
....

M_h or $M_A \leq 40$ GeV

$Z \rightarrow hZ$ $\sim \sin(\beta - \alpha)$

hA $\sim \cos(\beta - \alpha)$

$b\bar{b} h/A, \tau\bar{\tau} h/A \sim \tan\beta \frac{\sin(\beta - \alpha)}{\sin(\beta - \alpha)}$ ← large

$h/A \gamma \sim \tan\beta \frac{\sin(\beta - \alpha)}{\sin(\beta - \alpha)}$ ← small and large

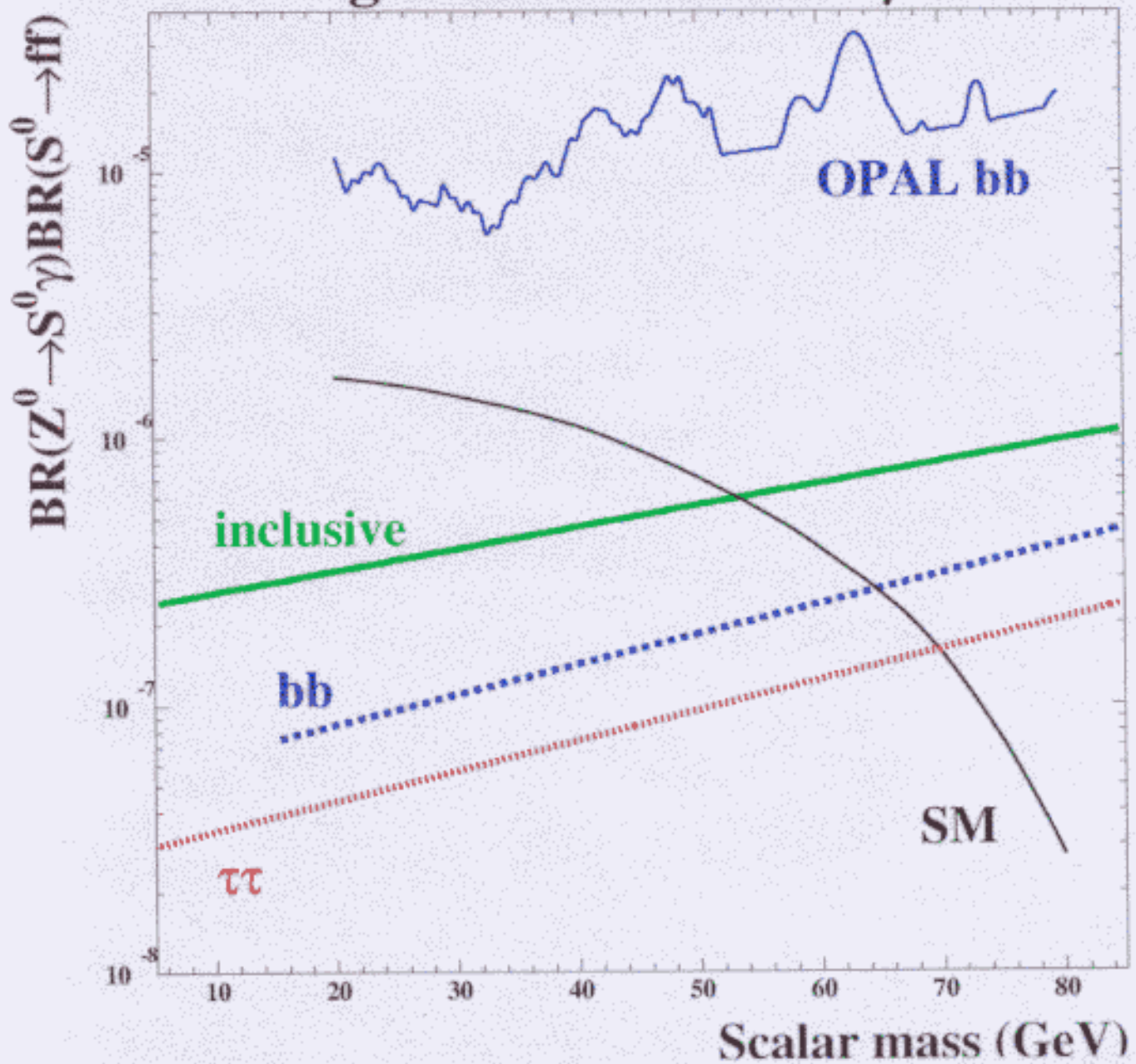
↓
various contributions

W^\pm (for h only)

H^\pm (for h only)

fermions

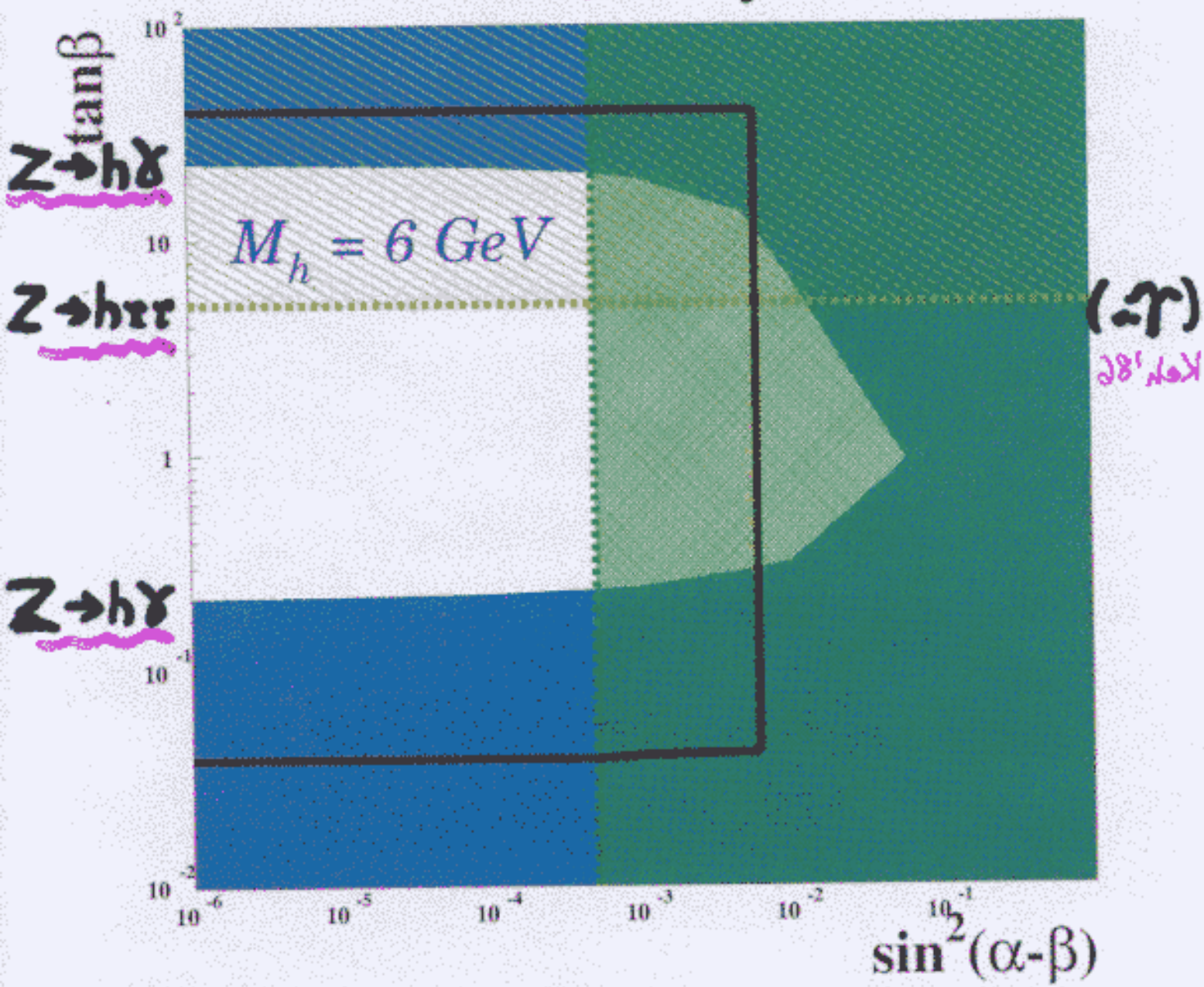
GigaZ limits for $S^0 + \gamma$



$$S_{LC} = S_{LEP} \sqrt{\frac{\mathcal{L}_{LEP}}{\mathcal{L}_{LC}}} \sqrt{\frac{(dN_{ff})_{LC}}{(dN_{ff})_{LEP}}} \frac{\epsilon_{sig}^{LEP}}{\epsilon_{sig}^{LC}} \frac{\sqrt{\epsilon_{bc}^{LC}}}{\sqrt{\epsilon_{bc}^{LEP}}}$$

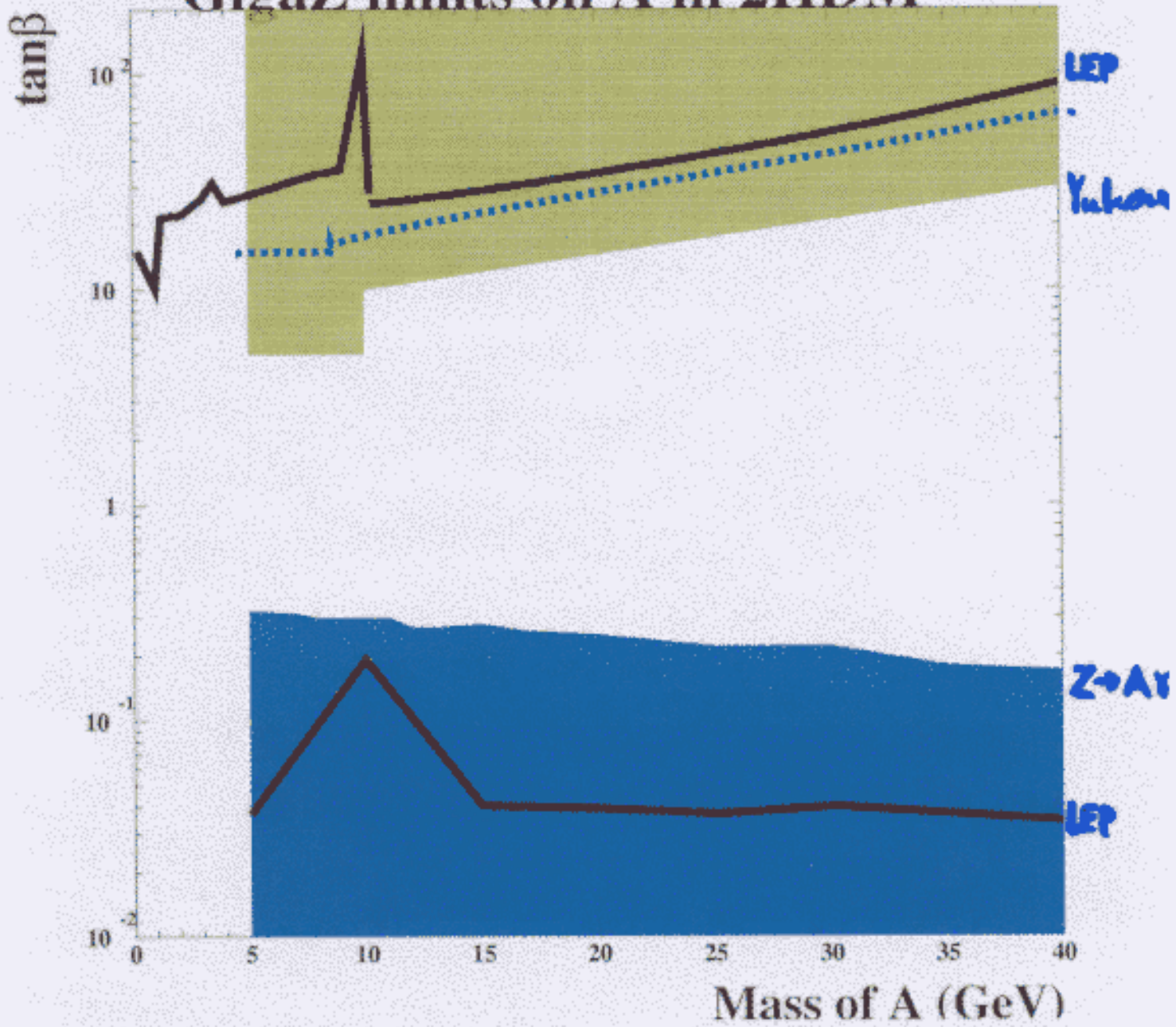
G.Z

L3 (Z → Zh)



LEP 1

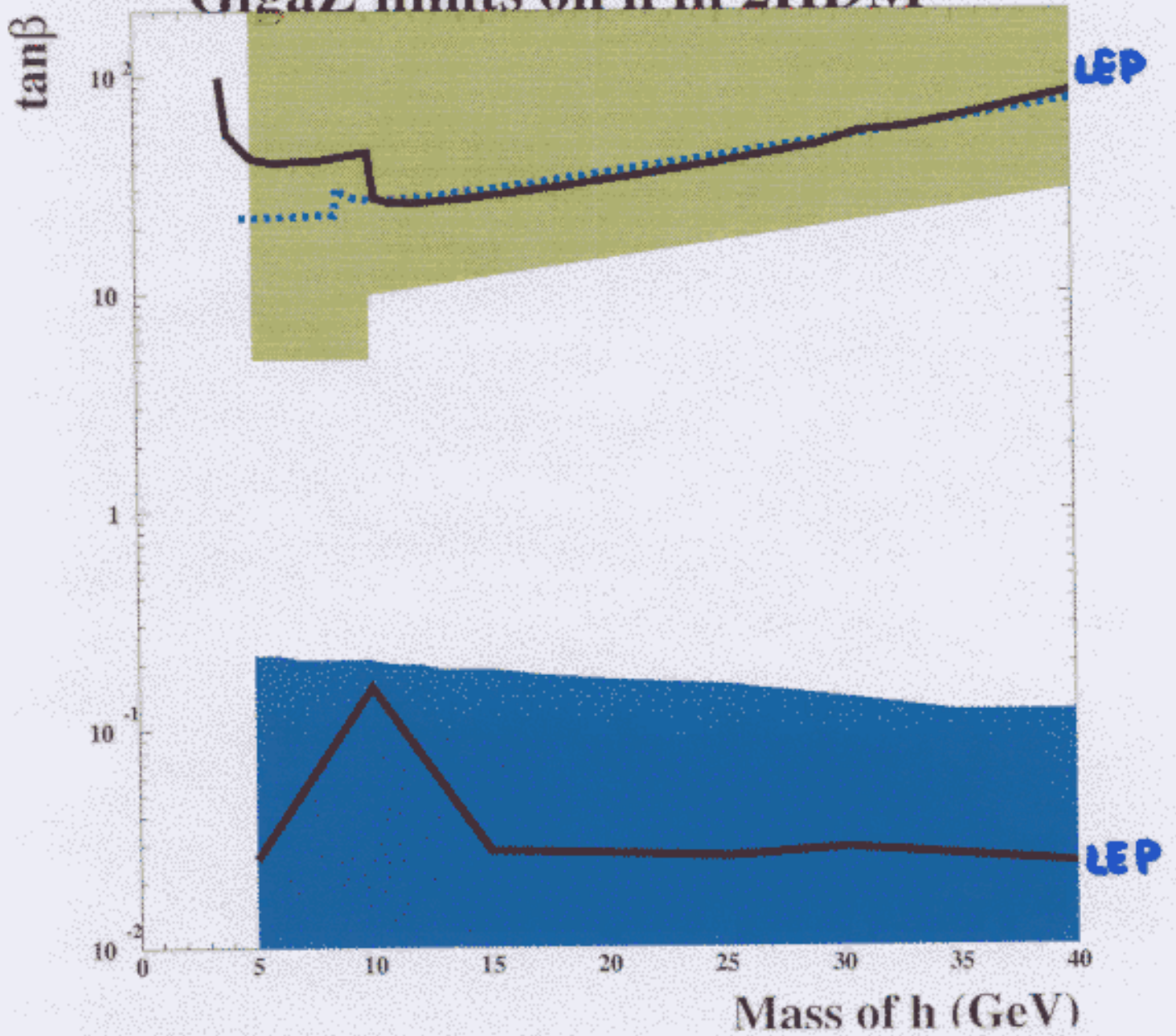
GigaZ limits on A in 2HDM



$$Z \rightarrow f\bar{f}A$$

$$\rightarrow A\gamma$$

GigaZ limits on h in 2HDM



$$\sin(\beta - \alpha) = 0$$

Open light Higgs window
in 2HDM

even at Giga Z

Can we close it by

→ looking at heavier
Higgs boson?

→ EW precision measurements
at Giga Z

- constraints on light h/A
(work in progress)

