WHAT CAN WE LEARN FROM PRECISION MEASUREMENTS ON HIGGS BOSONS ?

Patrick JANOT - CERN.

OUTLINE.

1.- THE LANDSCAPE BEFORE THE F.M.C. (*)

2.- PRECISION MEASUREMENTS AT THE F.M.C.

3.- WHAT CAN WE LEARN FROM THESE MEASUREMENTS IF NATURE ≡ MSSM. ?

   3.a.- CHOICE OF A STUDY POINT
   3.b.- WHAT CAN THE F.M.C. SAY ABOUT THIS POINT ?
   3.c.- A WORD ABOUT HIGGS COUPLINGS

4.- AND THEN, WHAT CAN WE LEARN FROM A SMC ? (**)

5.- CONCLUSIONS

Prospective Study on Muon Colliders at CERN
Plenary Session - 13/11/98

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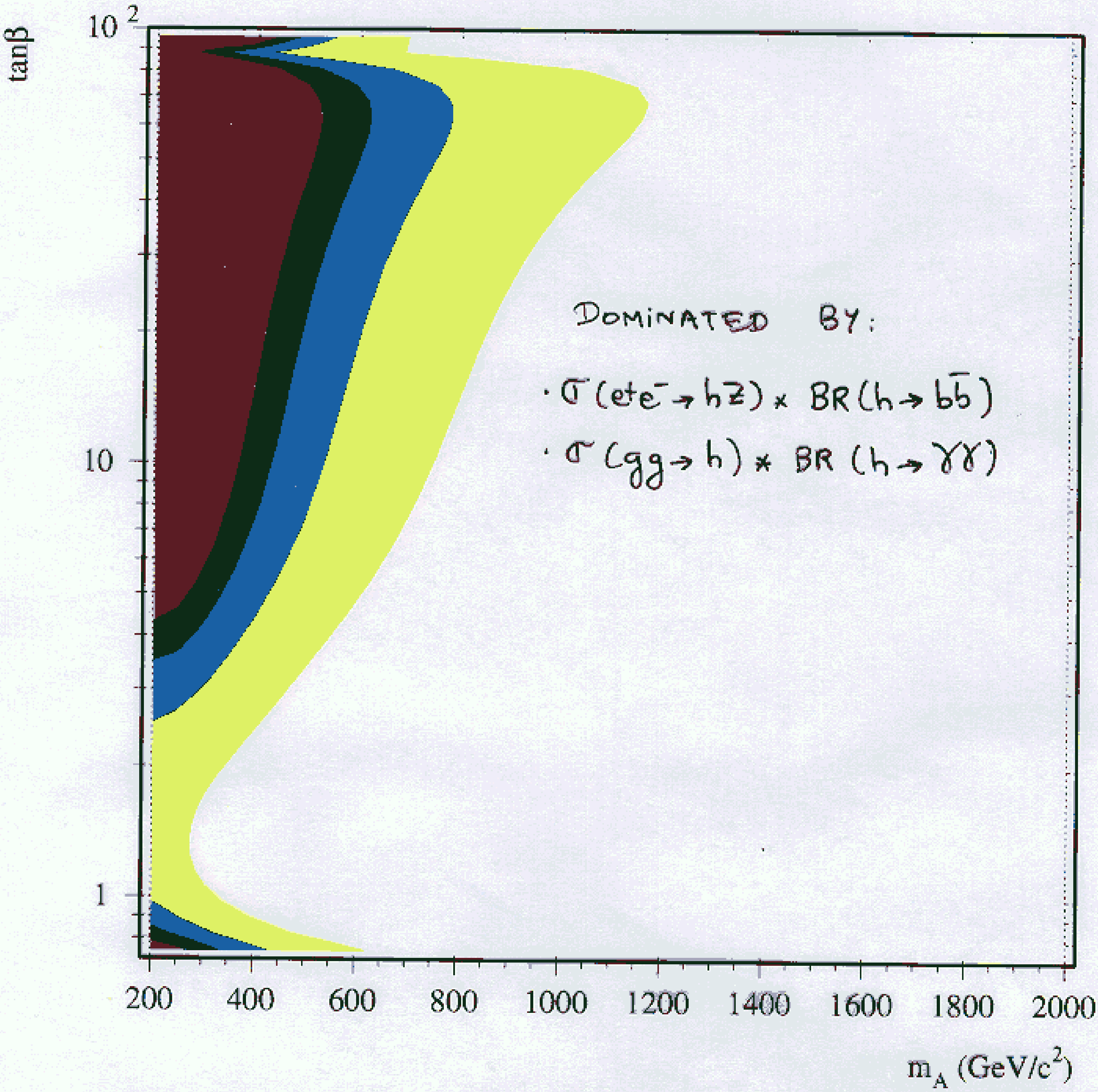
C. COMPATIBILITY OF THE MEASUREMENTS WITH THE S.M.

e.g. ASSUME THAT NATURE IS DESCRIBED BY THE M.S.S.M WITH $M_{SUSY} = A_t = \mu = 1$ TeV (SEE LATER FOR DETAILS)

$> 5\sigma$ $4-5\sigma$ $3-4\sigma$

$2-3\sigma$ $1-2\sigma$ $< 1\sigma$

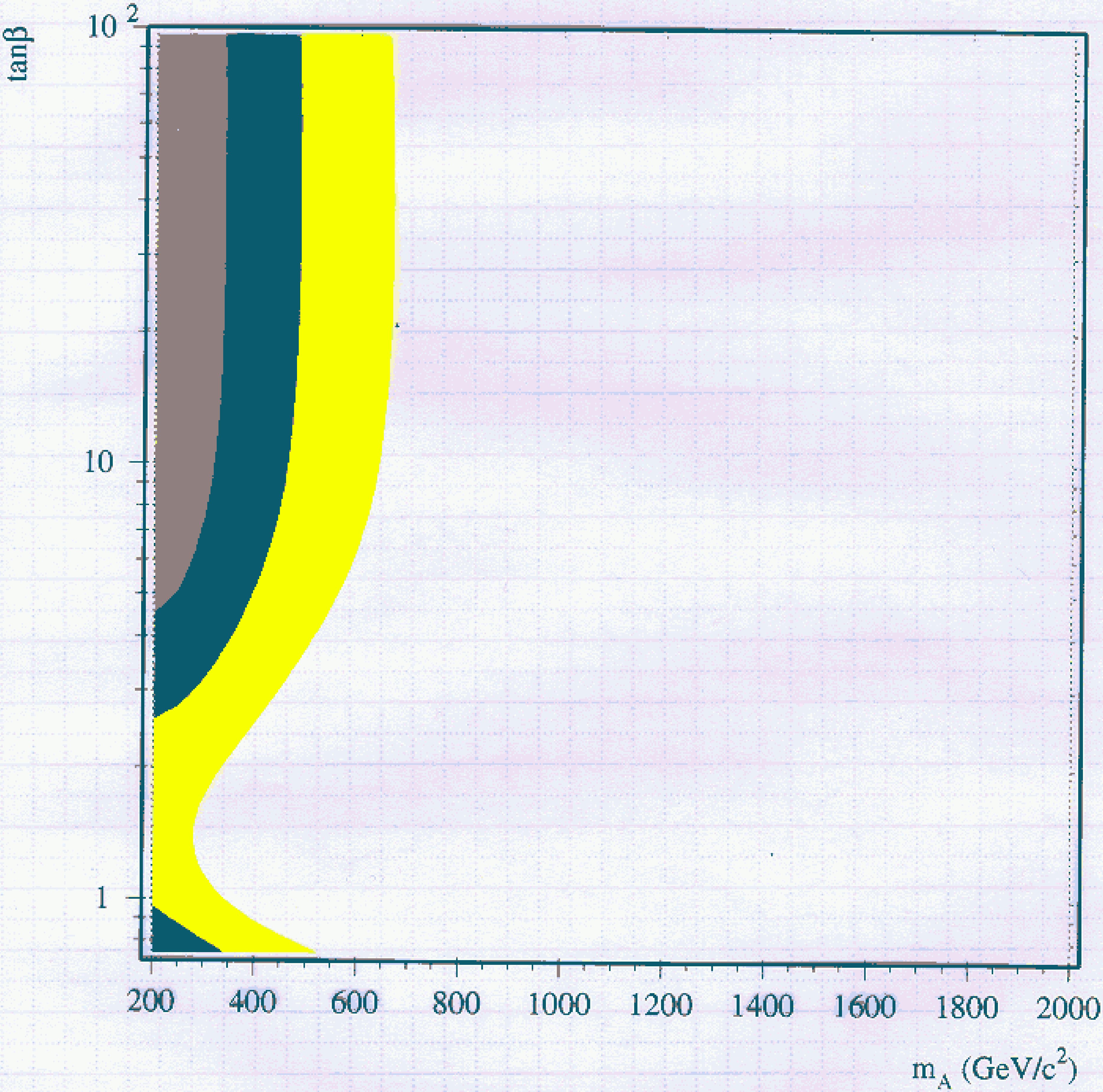


⇝ NOT MUCH SENSITIVITY ABOVE LC KINEMATIC LIMIT ($m_A \gtrsim 250$ GeV/c^2), EXCEPT AT HIGH $\tan\beta$, WHERE LHC WOULD START DISCOVERING $H, A \to \tau\tau$

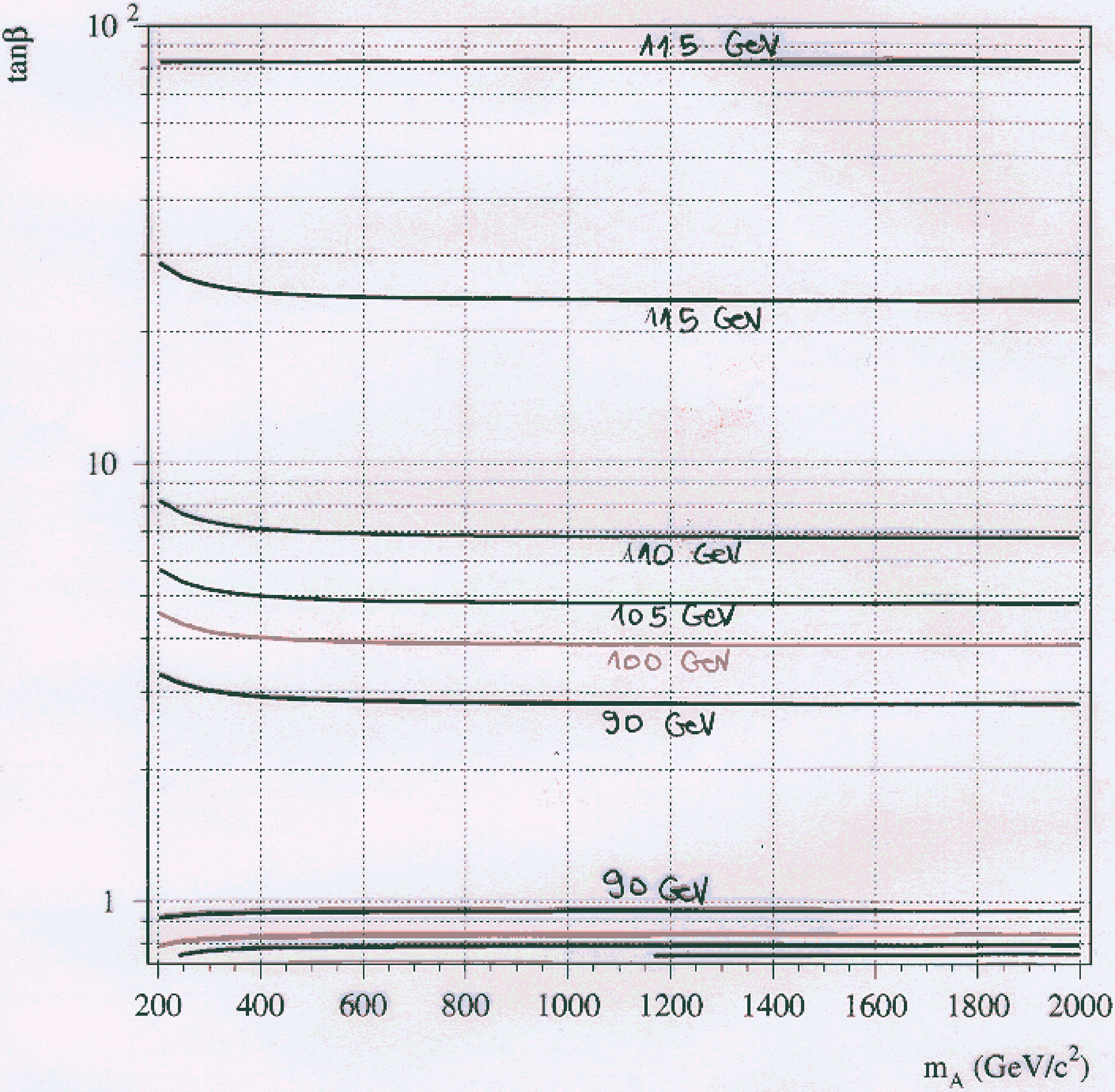
⇝ SIMILAR PATTERNS FOR OTHER $\{M_{SUSY}, A_t, \mu\}$

e.g. : PATTERN FOR $M_{SUSY} = 1 TeV/c^2$

$A_t, \mu \ll M_{SUSY}$.



NOTE: m_h VALUES IN $(m_A, \tan\beta)$ PLANE
FOR $M_{SUSY} = A_t = \mu = 1$ TeV

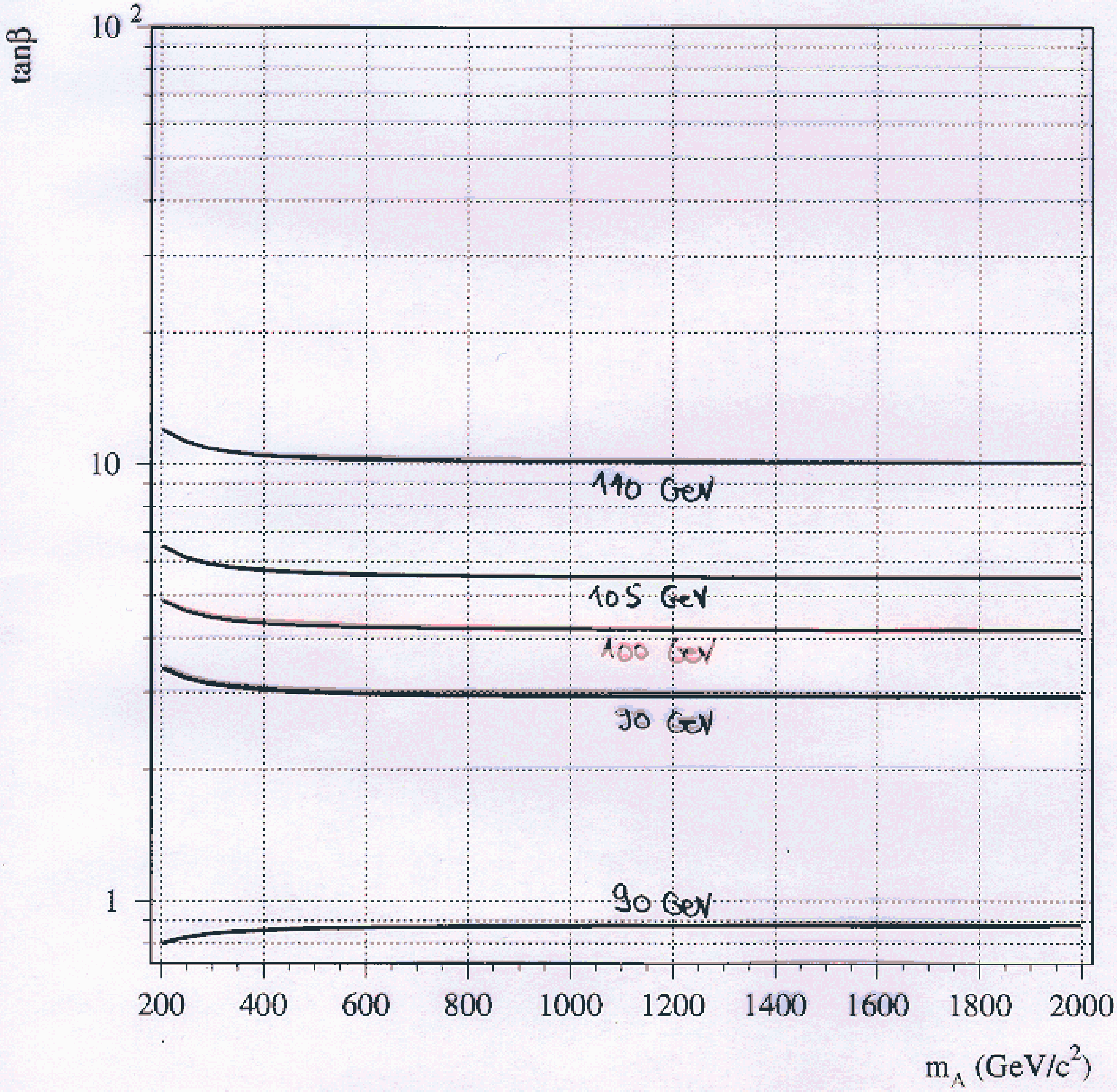


⇝ ANY ACCURACY ON m_h WILL TELL CLOSE TO NOTHING ABOUT m_A !

HOWEVER: $m_h = 110$ GeV $\Rightarrow \tan\beta \simeq 7$?

BUT IT WILL TELL CLOSE TO NOTHING ABOUT $\tan\beta$ AS WELL ...

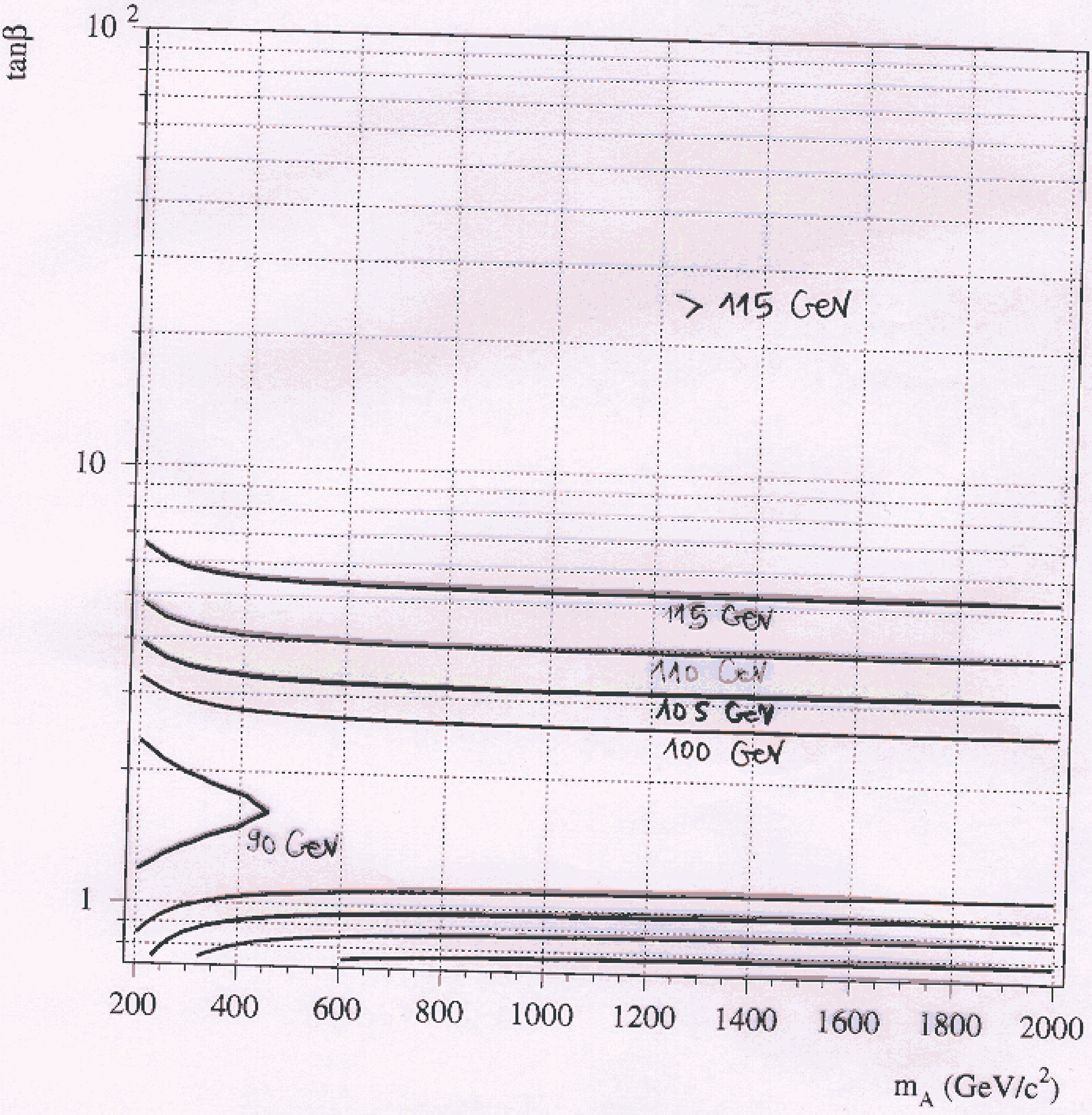
e.g. FOR $A_t, \mu \ll M_{SUSY}$



$m_h = 110$ GeV $\Rightarrow \tan\beta \simeq 10$

OR, FOR $\mu \ll M_{SUSY}$

$$A_t = \sqrt{6}\, M_{SUSY}$$

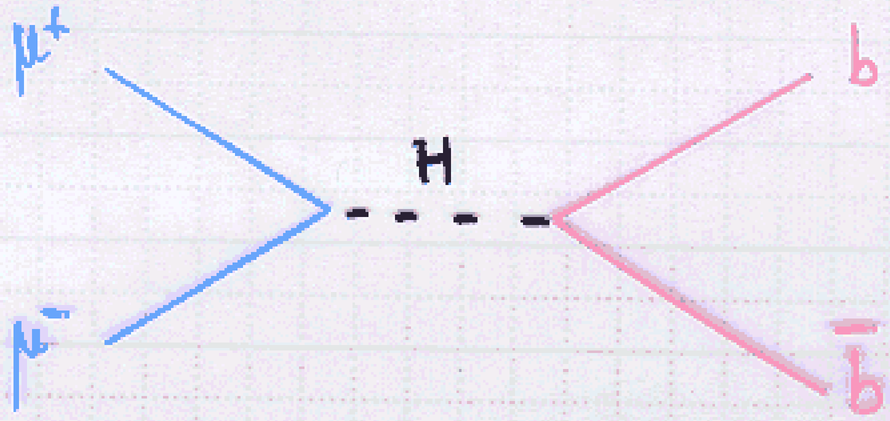


$$m_H = 110 \text{ GeV} \Rightarrow \tan\beta \simeq 4 \quad !$$

HMMM ... NOT VERY ENCOURAGING, IS IT?

2.- PRECISION MEASUREMENTS AT THE F.M.C.

- AIM: MEASURE, THROUGH $\mu^+\mu^- \to H$ PRODUCTION:



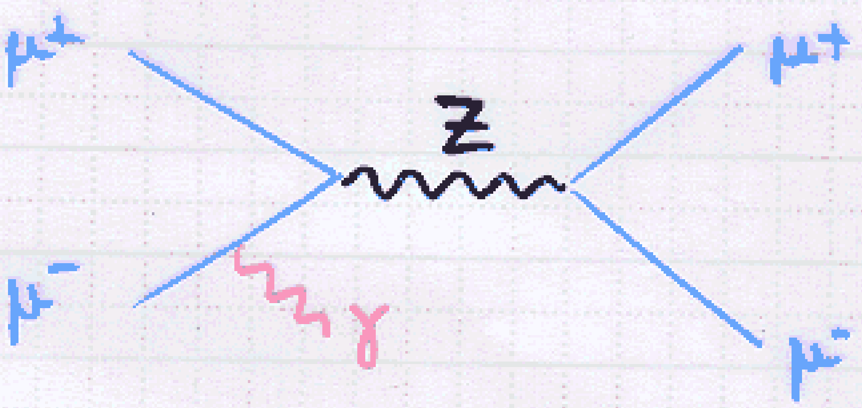
1) m_H ; 2) Γ_H ; 3) $\sigma^{PEAK}(\mu^+\mu^- \to H \to b\bar{b})$

WITH A SCAN OF THE RESONANCE FOR 1) AND 2) AND WITH A HIGH LUMINOSITY RUN AT $\sqrt{s} \sim m_H$ FOR 3).

- LUMINOSITY MEASUREMENT WITH:

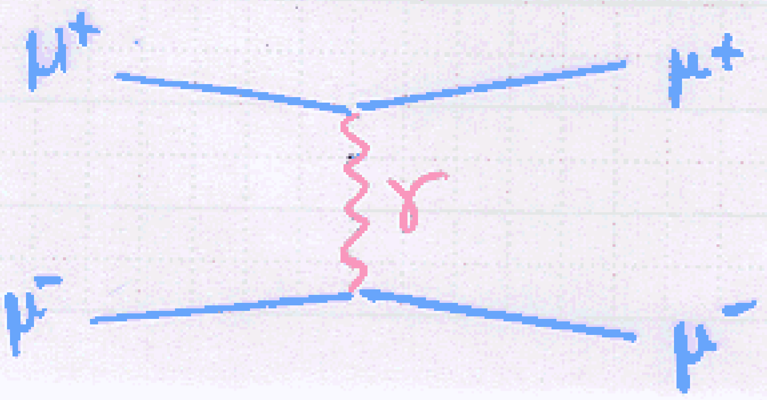
PRECISION $\frac{\Delta\mathcal{L}}{\mathcal{L}} \sim \frac{5\%}{\sqrt{\mathcal{L}}}$

a) RADIATIVE RETURN TO THE Z



CROSS-SECTION $\sim$ 300 pb FOR $\sqrt{s} = 110$ GeV

b) WIDE ANGLE MHAMHA'S ($> 25°$)

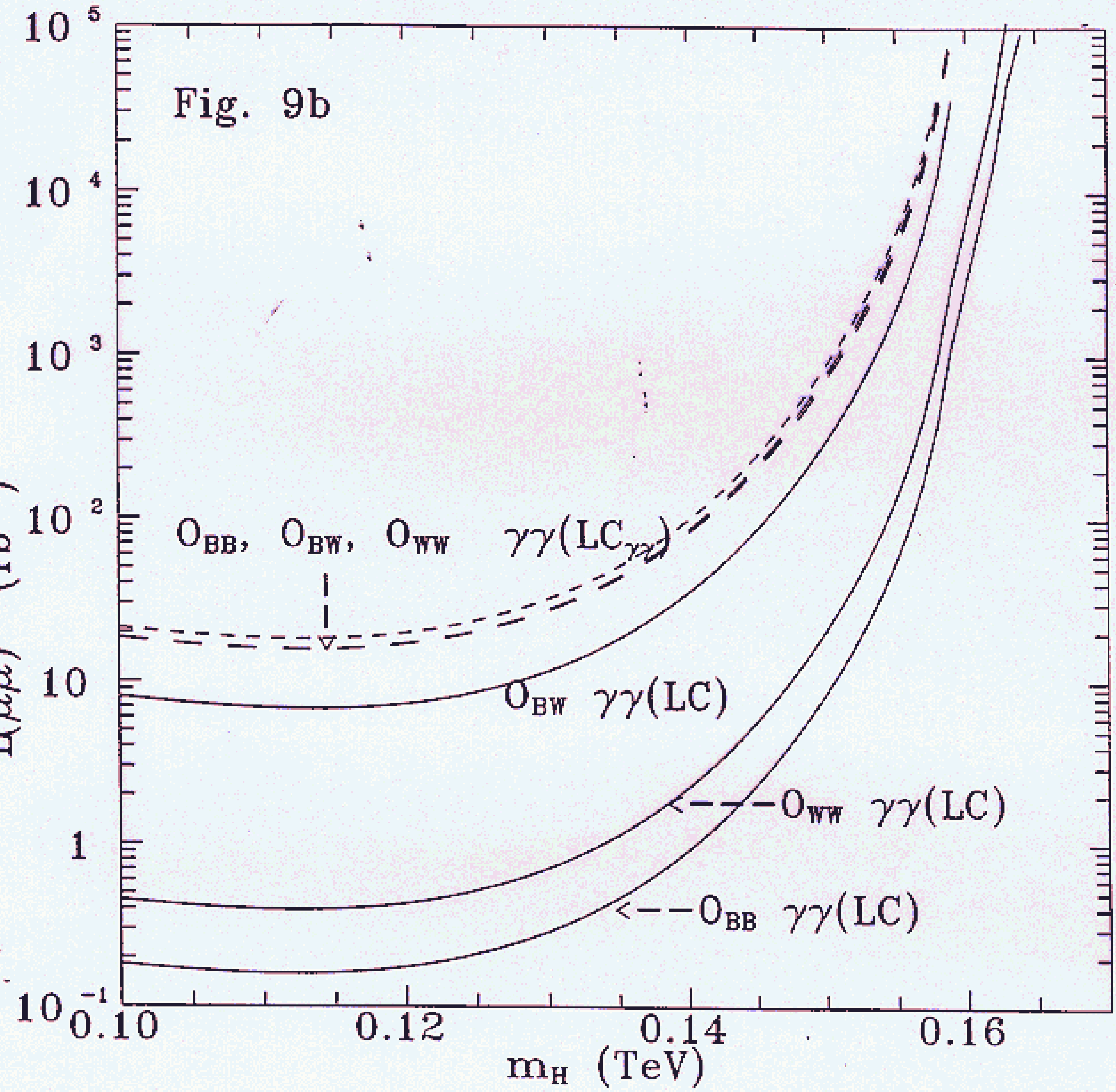


CROSS-SECTION $\sim$ 500 pb FOR $\sqrt{s} = 110$ GeV

FERNAND RENARD

ASSUME HIGGS COUPLINGS MODIFIED DIMENSION 6 OPERATORS.

⇒ EFFECT ON Γ_H



MINIMUM LUMINOSITY NEEDED TO IMPROVE CONSTRAINTS ON THE COUPLINGS SET BY PREVIOUS COLLIDERS

(0.1 → 10 fb^{-1}, EXCEPT IF A $\gamma\gamma$ COLLIDER HAS BEEN OPERATED)

TO SUMMARIZE

- ANY F.M.C. AT $\sqrt{s} = m_h$ CAN "PREDICT" m_A WITH A PRECISION NOT BETTER THAN 20% (i.e. 60 GeV/c^2 FOR m_A = 300 GeV/c^2).

- THIS IS DOMINATED BY THEORETICAL UNCERTAINTIES IN THE SUSY SCALE (DISCOVERING $\tilde{t}$ AND $\chi^{\pm}$ WOULD HELP!)

- STATISTICAL PRECISION IS 5% OR BETTER AND IMPROVES TO BETTER THAN 0.5% WITH 100 TIMES MORE LUMINOSITY

- NO $\mu^+\mu^-$ COLLIDER WOULD COMPLETELY SPOIL THIS PREDICTION CAPABILITY ON m_A. ACCESSIBLE PARAMETER SPACE GREATLY REDUCED

- A $\mu^+\mu^-$ COLLIDER GREATLY EXTENDS(*) THE POSSIBILITY OF EXCLUDING THE STANDARD MODEL (SEE NEXT PLOTS) EVEN IF THE PREDICTION ACCURACY IS LIMITED.

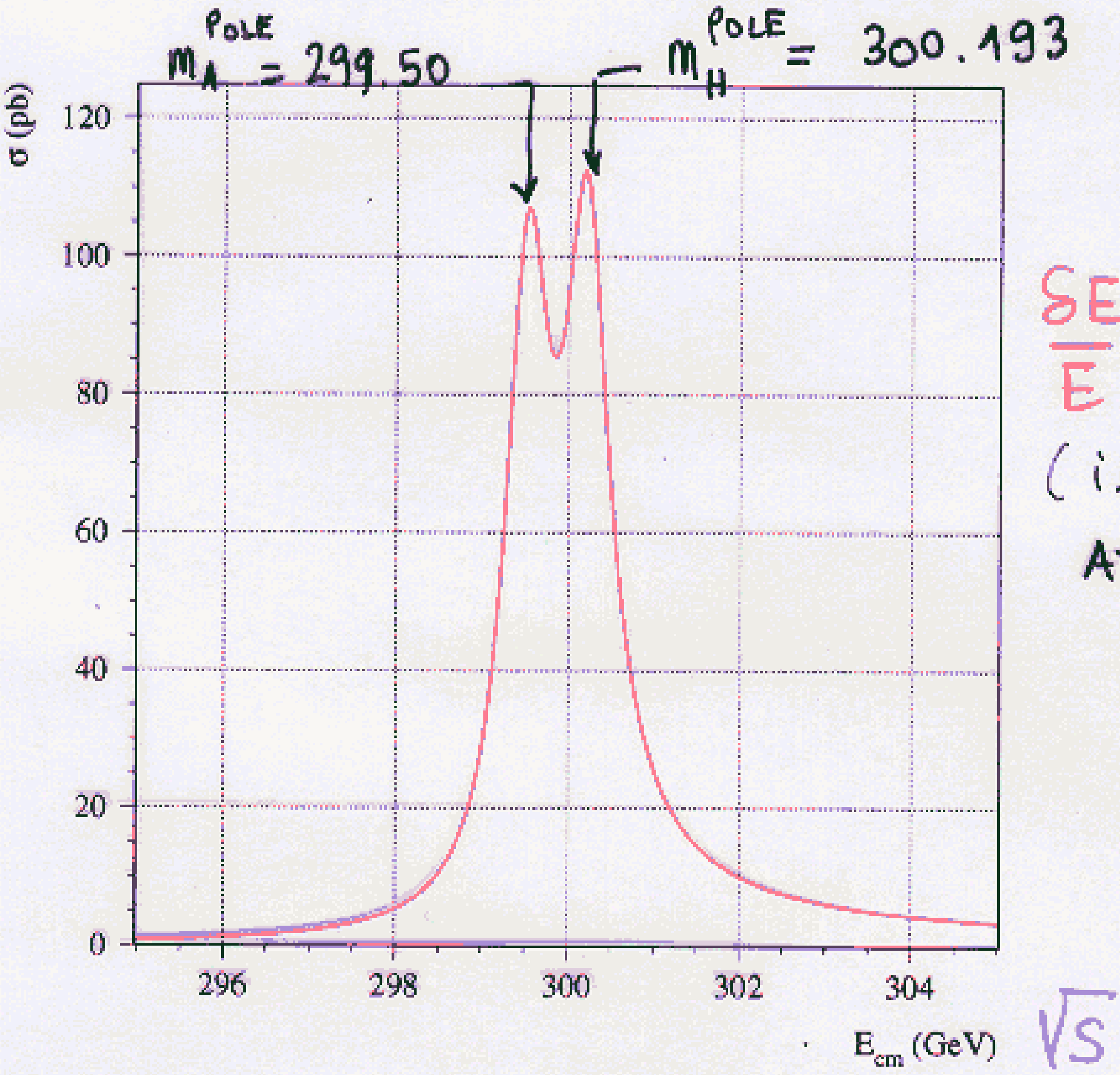
(*) ESPECIALLY FOR LARGE LUMINOSITY ($\gg$ 100 pb^{-1})

4.- AND THEN, A SECOND $\mu^+\mu^-$ COLLIDER ?

- SCAN AROUND THE PREDICTED VALUE OF m_A ($\pm$ 30 GeV/c^2 WITH OUR EXAMPLE)

- SINCE $m_A \sim m_H$, AND $\Gamma_A \sim \Gamma_H \sim$ 600 MeV, A SCAN WITH 2 GeV STEPS, LESS THAN 1 pb^{-1} PER STEP IS ENOUGH.

$\sigma(\mu\mu \to H, A)$



$\sqrt{s}$

$\frac{\delta E}{E} = 3.10^{-5}$ (i.e., 10 MeV AT 300 GeV)

- THEN MEASURE m_H, m_A UP TO 20 MeV/c^2 (NOT CRUCIAL), Γ_H, Γ_A UP TO 100 MeV (NOT DOMINANT) AND $\sigma(\mu\mu \to H, A \to b\bar{b})$ UP TO 1 pb ACCURACY (REQUIRES ~ 100 pb^{-1} AT BOTH PEAK POSITIONS)

- AND FIT EVERYTHING FOR $\tan\beta$, m_A, M_{SUSY}, A_t, μ.

RESULT OF THE FIT FOR ONE FICTITIOUS EXPERIMENT

	INPUT VALUE
$\tan\beta = 9.89$	(10.0)
$m_A = 299.6\ \mathrm{GeV}/c^2$	(300.0)
$M_{SUSY} = 1.11\ \mathrm{TeV}/c^2$	(1.0)
$A_t = 0.92\ \mathrm{TeV}$	(1.0)
$\mu = 0.42\ \mathrm{TeV}$	(1.0)

WITH $\chi^2 = 11.9$

- A FIT FOR SEVERAL VALUES OF $\tan\beta$ (e.g., $\chi^2 = 36$ FOR $\tan\beta = 11$, $\chi^2 = 317$ FOR $\tan\beta = 8$) GIVES AN ESTIMATE ON $\sigma_{\tan\beta}$:

$$\boxed{\sigma_{\tan\beta} \sim 0.4} \qquad [\tan\beta \in [9.6\,;\,10.4]]$$

- LETTING ALL OTHER PARAMETERS FREE, BUT ONE

  M_{SUSY}, A_t AND μ ARE STILL VERY MUCH CORRELATED. NO PRECISE PREDICTION IS REALLY POSSIBLE.

- OF COURSE, THE ERROR ON m_A^{RUN} REMAINS SMALL

$$\boxed{\sigma_{m_A} \sim 0.5\ \mathrm{GeV}/c^2}$$

5. CONCLUSIONS

- IN THE HYPOTHESIS IN WHICH ONLY ONE STANDARD MODEL-LIKE HIGGS BOSON IS FOUND AT LHC/NLC, A FIRST MUON COLLIDER AT $\sqrt{s} \simeq m_h$, $\Delta E/E \sim 3 \cdot 10^{-5}$, $\mathcal{L} = 0.1 - 10 \ fb^{-1}$ WOULD EXTEND / GREATLY EXTEND THE CONSTRAINTS ON THE STANDARD MODEL (OR OTHER MODELS)

  [IN TERMS OF MSSM, $m_A > 250 \ GeV/c^2$ WILL BECOME $m_A > 1-2 \ TeV/c^2$]

- IF THE NATURE IS SUPERSYMMETRIC, A FMC WILL PREDICT THE A MASS WITH A 20% ACCURACY (THEORY UNCERTAINTY)

- A SECOND MUON COLLIDER AT $\sqrt{s} \sim m_A$ WILL:
  1) DISCOVER H AND A
  2) CONSTRAIN $\tan\beta$ (e.g: 10 ± 0.4)

- NO REAL CONSTRAINT CAN BE OBTAINED ON THE OTHER PARAMETERS OF THE MODEL BUT MSSM TESTS CAN START.

NOTE: FOR COMPARISON, LEP CONSTRAINED m_{top} to $\pm 10 \ GeV/c^2$, m_H to $\pm 100 \ GeV/c^2$ AND CONFIRMED THE EXISTENCE OF THREE NEUTRINO SPECIES...

B. MURRAY

Scan of the Higgs

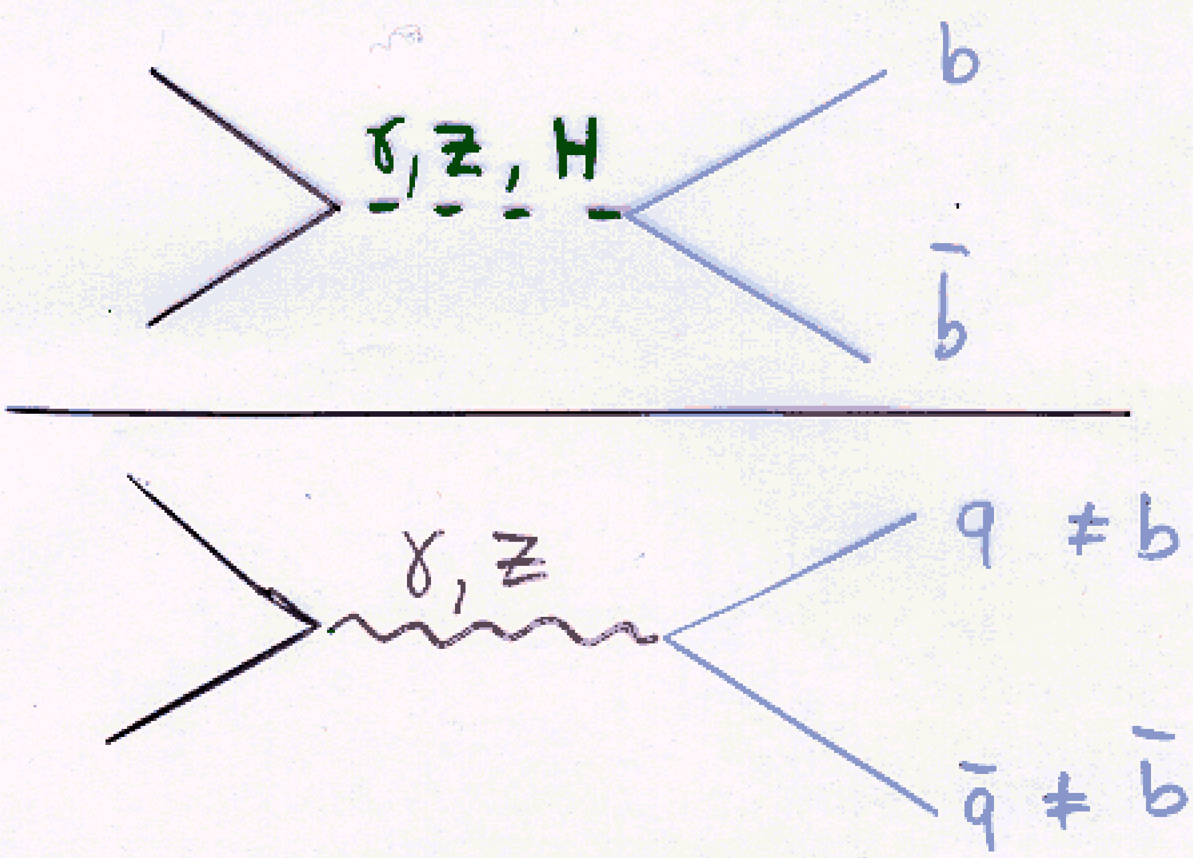
The quick model mentioned earlier is used. It has:

- 25 degree angle acceptance
- 2% random particle loss at higher angle
- 1.3GeV momentum error at 50GeV
- E.M. resolution 10%/ $\sqrt{E}$
- Hadronic resolution 100%/ $\sqrt{E}$
- Minimum energy 1GeV for neutral, 0.3GeV for charged

The B tagging is taken (roughly) from DELPHI:
80% of b events and 5% of non-b events are tagged

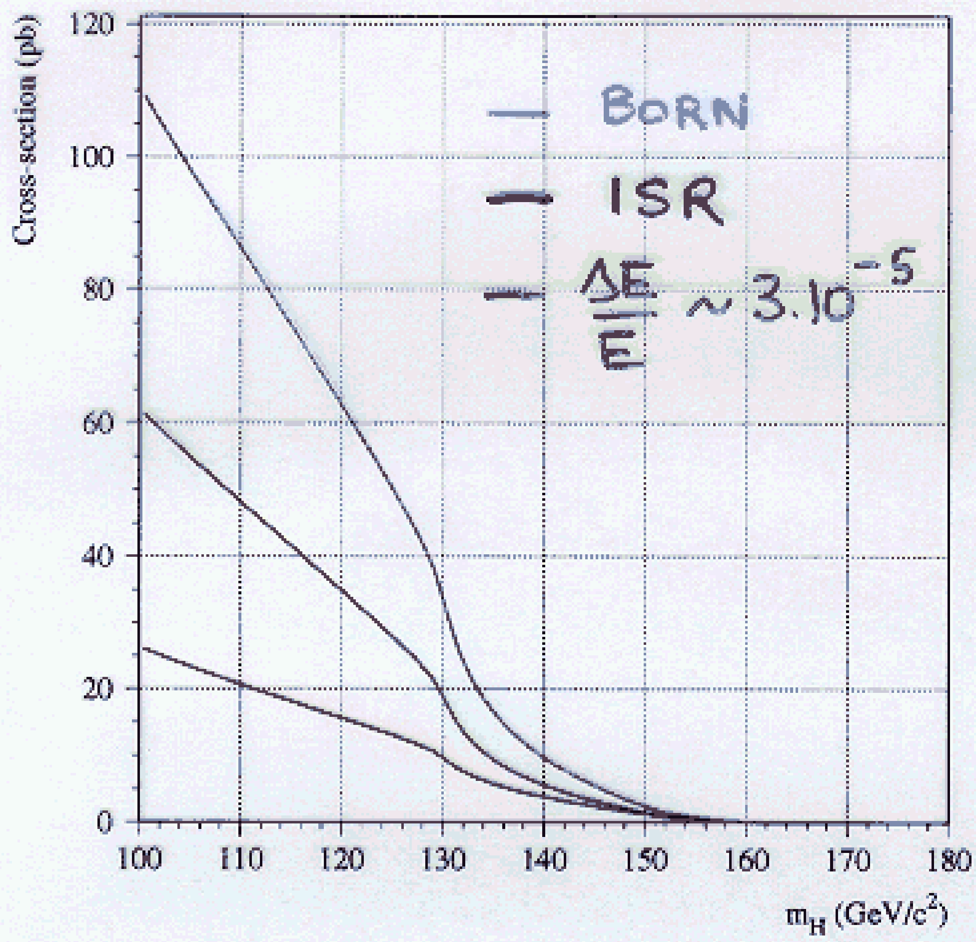
Fit luminosity and Higgs cross-section using to the following information from hadronic events:

- The number of radiative return events
- The number of non b-tagged full s' events
- The number and polar angle of b tagged full s' events.



⇒ MEASUREMENT CAN BE DONE WITHOUT $\mathcal{L}$ DETERMINATION, BUT IS IMPROVED WITH.

PLOTS OF $\sigma(\mu^+\mu^- \to H \to b\bar{b})$.



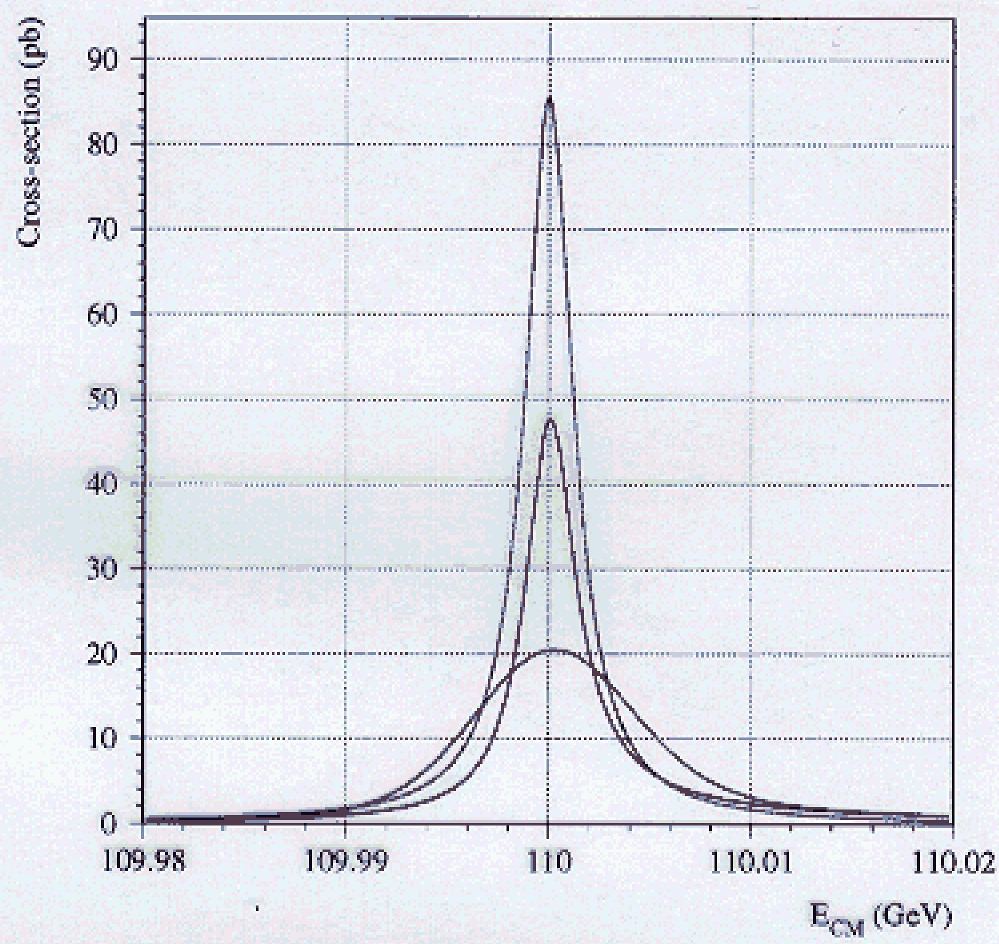
1) AS A FUNCTION OF m_H (σ_{peak})

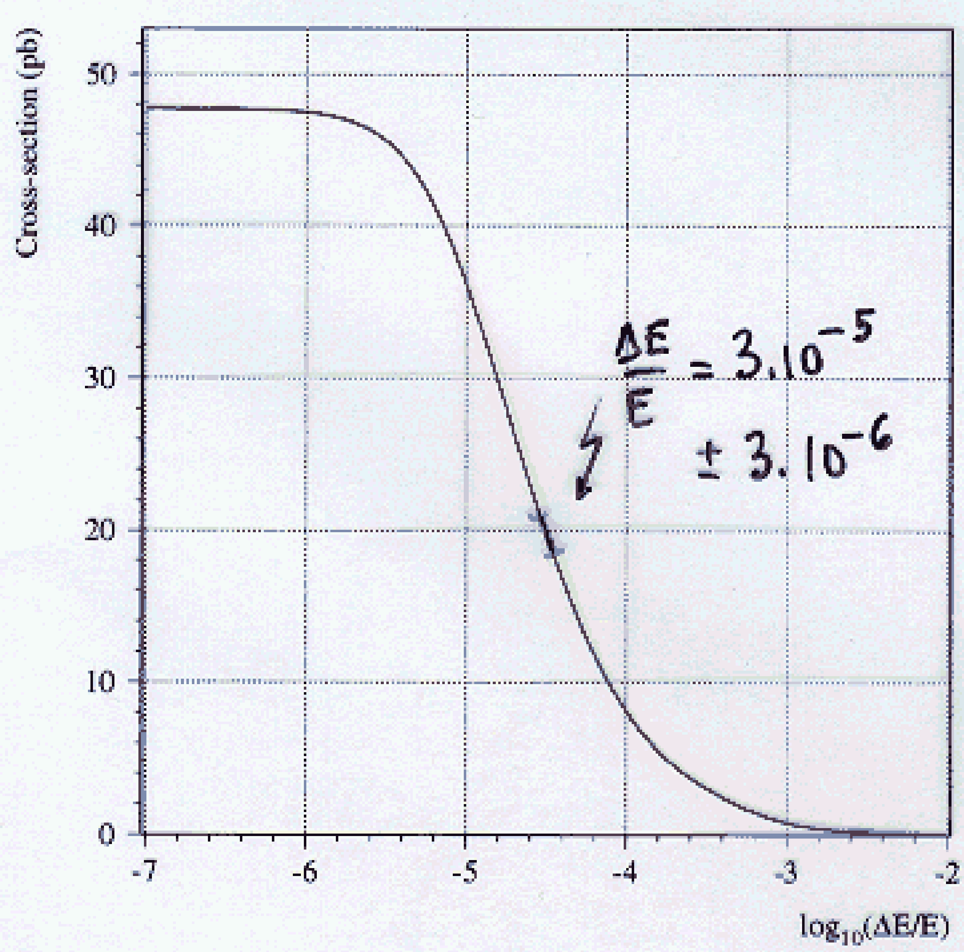
- QUITE IMPORTANT EFFECT FROM ISR
- RAPID DECREASE OF THE CROSS-SECTION WITH m_H

2) AS A FUNCTION OF $\sqrt{s}$

($m_H = 110$ GeV/c²)

- QUITE IMPORTANT EFFECT FROM BEAM ENERGY SPREAD
  - → LOWER σ_{PEAK}
  - → BROADER RESONANCE





3) AS A FUNCTION OF $\frac{\Delta E}{E}$ (σ_{PEAK})

- σ_{PEAK} VERY MUCH DEPENDENT ON $\frac{\Delta E}{E}$.

IF $\sigma\left(\frac{\Delta E}{E}\right) = 10\%$, $\sigma(\sigma_{PEAK}) \sim 5\%$

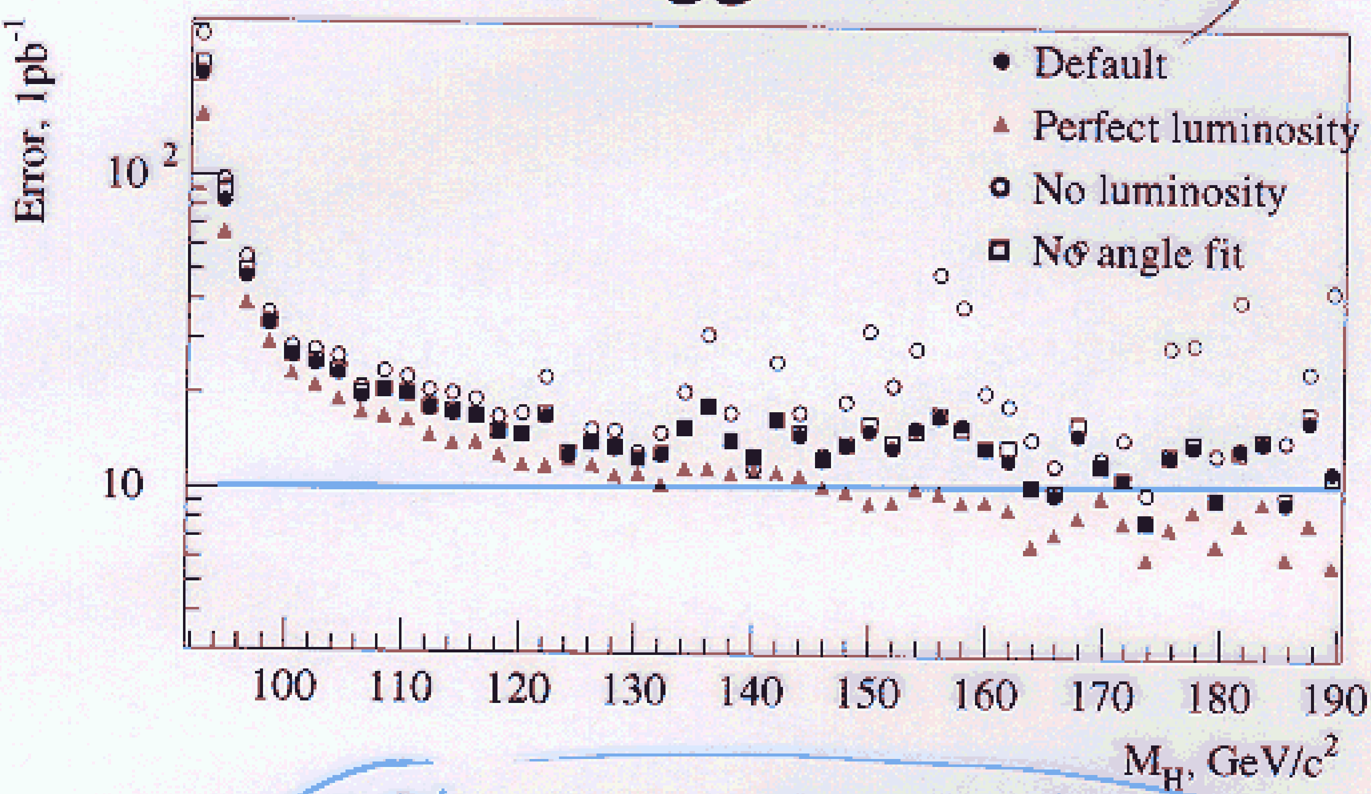
- $\Rightarrow$ NEED TO MEASURE σ_{PEAK}, PEAK−2, PEAK+2 !

Sensitivity v Higgs mass

$\mathcal{L} = 1 pb^{-1}$

NO MHAMHA'S !

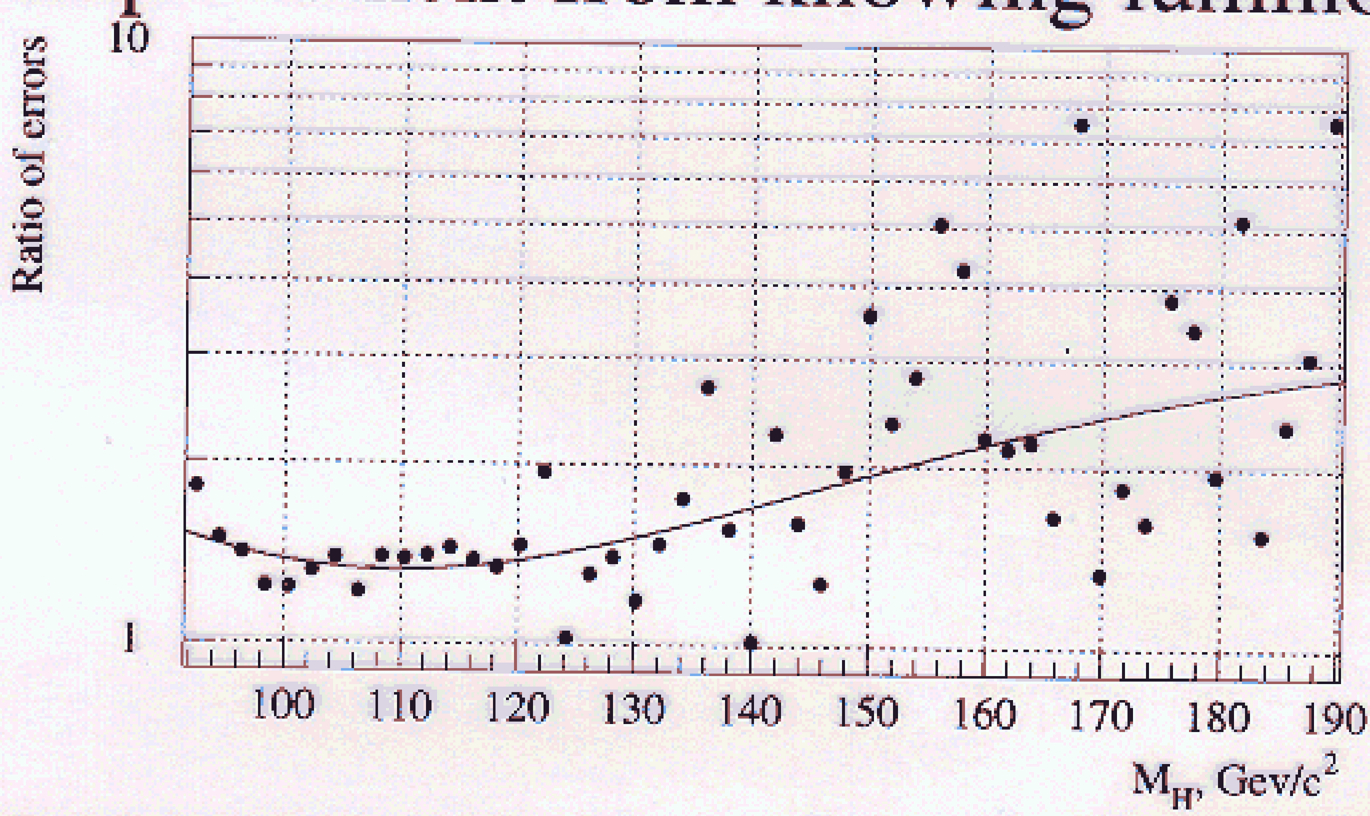
Error on Higgs cross-section



$\Delta\sigma_{PEAK} \sim 10\ pb/\sqrt{\mathcal{L}}$

Error on cross-section falls with energy - except no lumi.

Improvement from knowing luminosity



Perfect knowledge of luminosity helps by a factor 1.5 to 3, dependent upon Higgs mass.

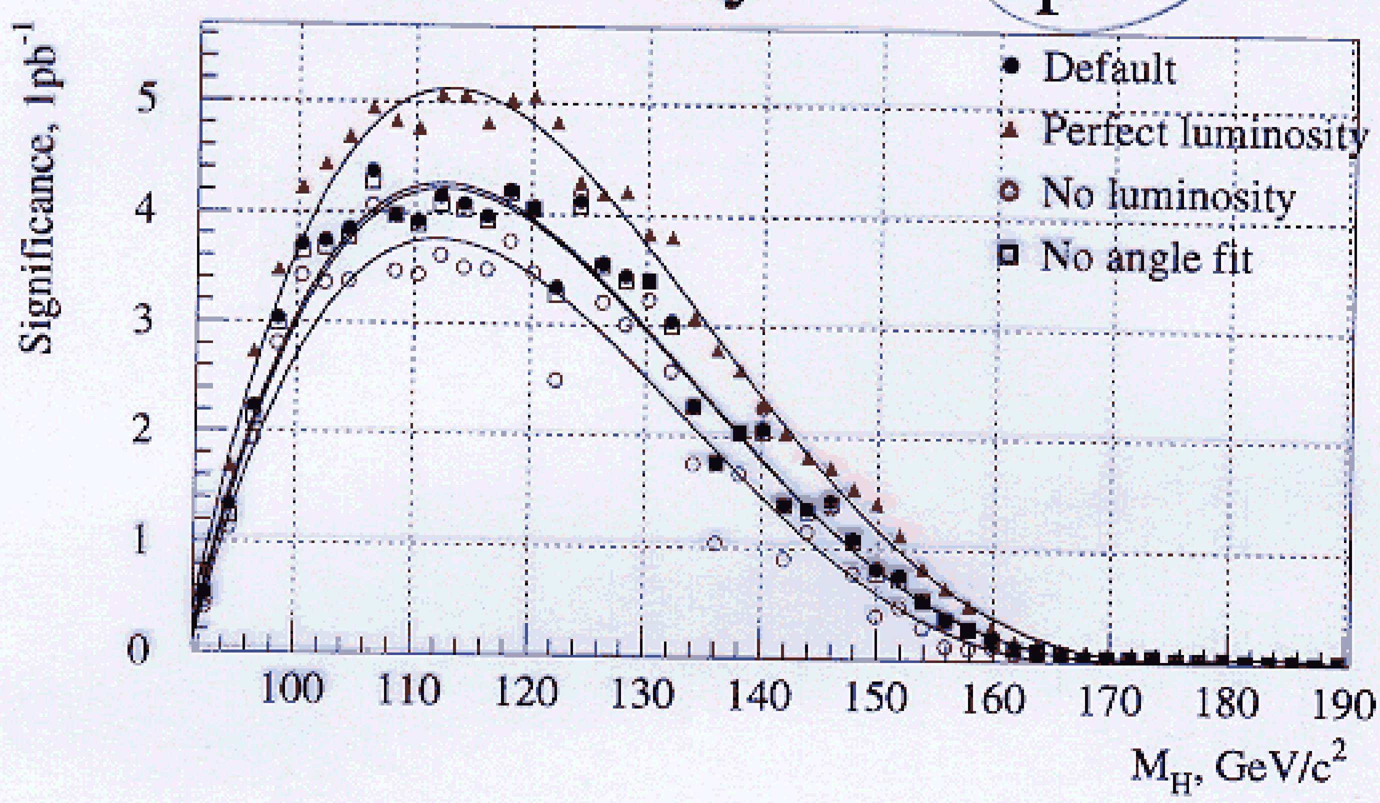
B. MURRAY

Sensitivity vs Higgs mass

(ONLY BORN LEVEL)

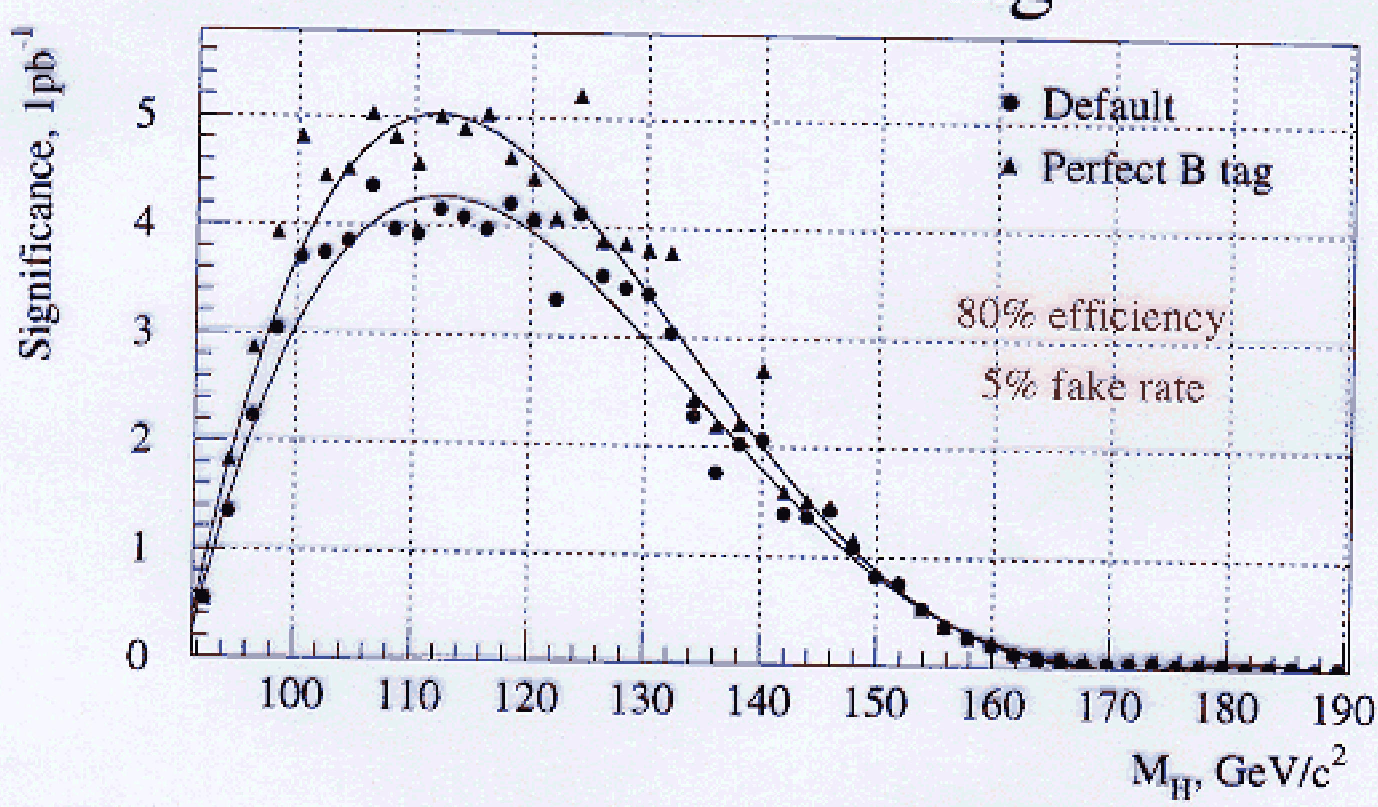
Discovery with $1pb^{-1}$

→ $16 pb^{-1}$ WITH ISR ON AND BEAM ENERGY SPREAD



110GeV is BEST POSSIBLE place for this measurement.
Use of vector-boson decays at high mass would help.

Effect of b tag



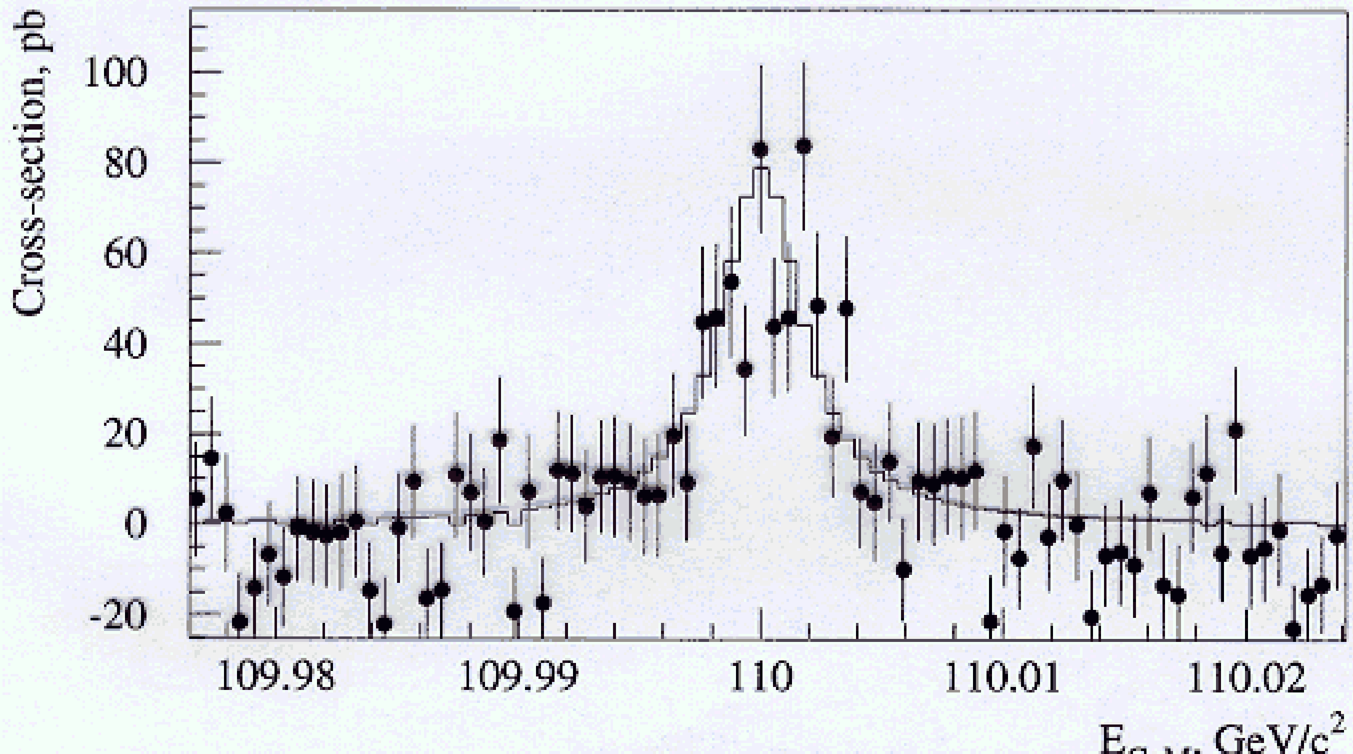
Flavour tagging is as important as luminosity measurement

B. MURRAY

Scan of Higgs resonance

16 pb⁻¹ (ONLY BORN LEVEL HERE)

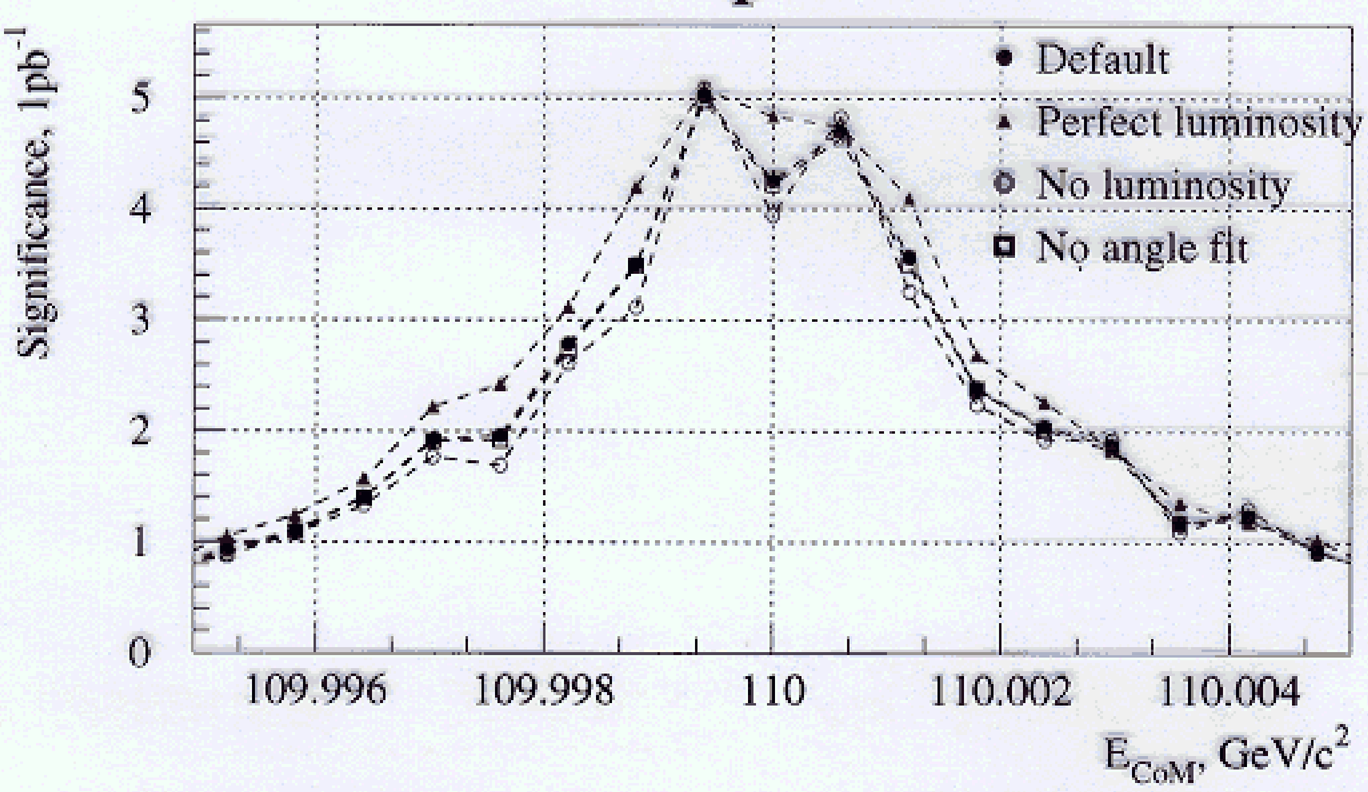
Scan, 1pb^{-1} per point



Measured cross-section

No beam error uncertainty is allowed for here.

Different possible fits



Scanning in 5MeV steps will give one 5 sigma or 2 two-sigma observations - 20 points for 100MeV.

≃ 300 pb^{-1} ⟺? ONE YEAR

THE PRECISION MEASUREMENTS

- $\sqrt{s} = m_h, \; m_h - 2, \; m_h + 2$ ↯ MeV/c^2 !
- $\mathcal{L} = 100 \, pb^{-1}$ / POINT ($\overset{?}{\Leftrightarrow}$ ONE YEAR)
- $\frac{\Delta E}{E} = 3.10^{-5} \pm$?

COULD AVOID THE THREE POINT STRATEGY IF IT WERE KNOWN TO ± 1% !

OBSERVABLE	ACCURACY
$\sigma(\mu^+\mu^- \to H \to b\bar{b})$ ↓	$\pm 10 \, pb / \sqrt{\mathcal{L}} \sim 5\%$
σ^0_{PEAK}	$\sim 5\%$
m_H	± 0.1 MeV/c^2
Γ_H	$\pm 0{,}5$ MeV/c^2

STANDARD

OUTSTANDING DESIGN: $\mathcal{L} = 10 \, fb^{-1}$ / YEAR

($10^{33} \, cm^{-2} s^{-1}$ INSTANTANEOUS LUMINOSITY)

$\Rightarrow$ 0.5% PRECISION ON $\sigma(\mu^+\mu^- \to H \to b\bar{b})$

3.- CHOICE OF A STUDY POINT FOR FMC.

- FOR THE SAKE OF DEFINITENESS, ASSUME THAT NATURE IS DESCRIBED BY THE MSSM.

→ HIGGS SECTOR DESCRIBED AT TREE-LEVEL BY TWO BASIC PARAMETERS

$$\tan\beta \; , \; m_A$$

+ RADIATIVE CORRECTIONS TO MASSES AND COUPLINGS DRIVEN BY M_{SUSY} (AVERAGE OF STOP MASSES):

$$\Delta m_h^2 \propto \frac{m_t^4}{m_W^2} \log \frac{M_{SUSY}}{m_t}$$

☆ NOTE: NO UNCERTAINTY WAS ASSUMED ON m_{top} ($\sigma_{m_{top}} \sim 100$ MeV)

AND BY STOP MIXING A_t AND μ

WHEN RELEVANT:

- * NO MIXING ≡ $A_t, \mu \ll M_{SUSY}$
- * TYPICAL MIXING ≡ $A_t = \mu = M_{SUSY}$
- * MAXIMAL MIXING ≡ $A_t = \sqrt{6}\, M_{SUSY}$; $\mu \ll M_{SUSY}$

SINCE THIS CHOICE IS ESSENTIALLY IRRELEVANT FOR WHAT FOLLOWS, I HAVE CHOSEN:

$$\boxed{A_t = \mu = M_{SUSY} = 1\ \text{TeV}}$$

- $\tan\beta$ AND m_A HAVE TO BE CHOSEN SUCH THAT ONLY ONE HIGGS BOSON IS DISCOVERED PRIOR THE FIRST MUON COLLIDER

  $\Rightarrow$ $\tan\beta$ MODERATE ($H, A \not\to \tau\tau$ AT LHC)

  $m_A > 250$ GeV/c^2 ($e^+e^- \not\to hA$ AT NLC)

- STICK TO THE SIMPLEST CASE TO START WITH, AND SEE WHAT THE F.M.C. CAN ABOUT IT

  $\Rightarrow$ $m_A = 300$ GeV/c^2
  $\tan\beta = 10$

- NOTE: IF A AND/OR H ARE DISCOVERED BEFOREHAND, GO TO SECTION 4.– TO SEE WHAT THE SECOND MUON COLLIDER (WHICH WOULD BECOME THE FIRST, IN THAT CASE) CAN DO.

CURRENT UNCERTAINTY ON THIS DIGIT.

$\Rightarrow$ $m_h = 113.25646$ GeV/c^2

(IF RAD. CORR. ARE TO BE BELIEVED TO THAT PRECISION, WHICH IS, OF COURSE, WRONG, BUT THAT I'LL ASSUME TO BE THE CASE AT THE TIME OF THE F.M.C. !!!)

3.6 WHAT CAN AN F.M.C. SAY ?

QUESTIONS.

- CAN IT PREDICT m_A WITH A DECENT PRECISION ?

- CAN IT DETERMINE $\tan\beta$?

- CAN IT SAY ANYTHING ABOUT M_{SUSY}, A_t, μ THROUGH RADIATIVE CORRECTIONS ?

- CAN IT (AT LEAST) EXTEND TEST OF THE STANDARD MODEL TOWARDS HIGHER m_A VALUES ?

THE PRECISION MEASUREMENTS { $\sqrt{s} = m_h$; $\frac{\Delta E}{E} = 3.10^{-5}$ }

OBSERVABLE	ACCURACY
m_h	$\pm$ 0.1 MeV/c^2
Γ_h	$\pm$ 0.5 MeV/c^2 (*) (I'LL ALSO SHOW RESULTS WITH $\pm$ 0.1 MeV/c^2)(**)
$\sigma(\mu^+\mu^- \to h \to b\bar{b})$	$\mp$ 10 pb/$\sqrt{\mathcal{L}}$ (BILL MURRAY)

S.M. VALUE : 18 pb { $100\ pb^{-1}$ (*) : $\pm$ 1 pb (5%) [illegible] ; $10\ fb^{-1}$ (**) : $\pm$ 0.1 pb (0.5%) [illegible] }

(*) STANDARD (**) OUTSTANDING.

A FICTITIOUS EXPERIMENT

INPUTS : $m_A = 300\ GeV/c^2$; $\tan\beta = 10$;
$M_{susy} = A_t = \mu = 1\ TeV$.

OBSERVABLE	TRUE VALUE	MEASURED	STANDARD MODEL
m_h	113.25646 GeV	113.25635 GeV	113.25646 GeV
Γ_h	4.88 MeV	5.59 MeV **	3.03 MeV
$\sigma(\mu\mu \to h \to bb)$	29.28 pb	28.03 pb ***	18.87 pb
$\sigma(ee \to hZ)\,BR(h \to bb)$	0.1620 pb	0.1599 pb **	0.1520 MeV
$\sigma(ee \to hZ)$	0.1954 pb	0.1976 pb ±	0.1956 pb
$\Gamma(h \to gg)\,BR(h \to \gamma\gamma)$	$2.92 \cdot 10^{-4}$ MeV	$4.62 \cdot 10^{-4}$ MeV *	$4.82 \cdot 10^{-4}$

- STANDARD FMC ACCURACY IS USED HERE
  (± 0.1 MeV on m_h, 0.5 MeV on Γ_h, 1 pb on $\sigma(\mu\mu \to h \to bb)$)

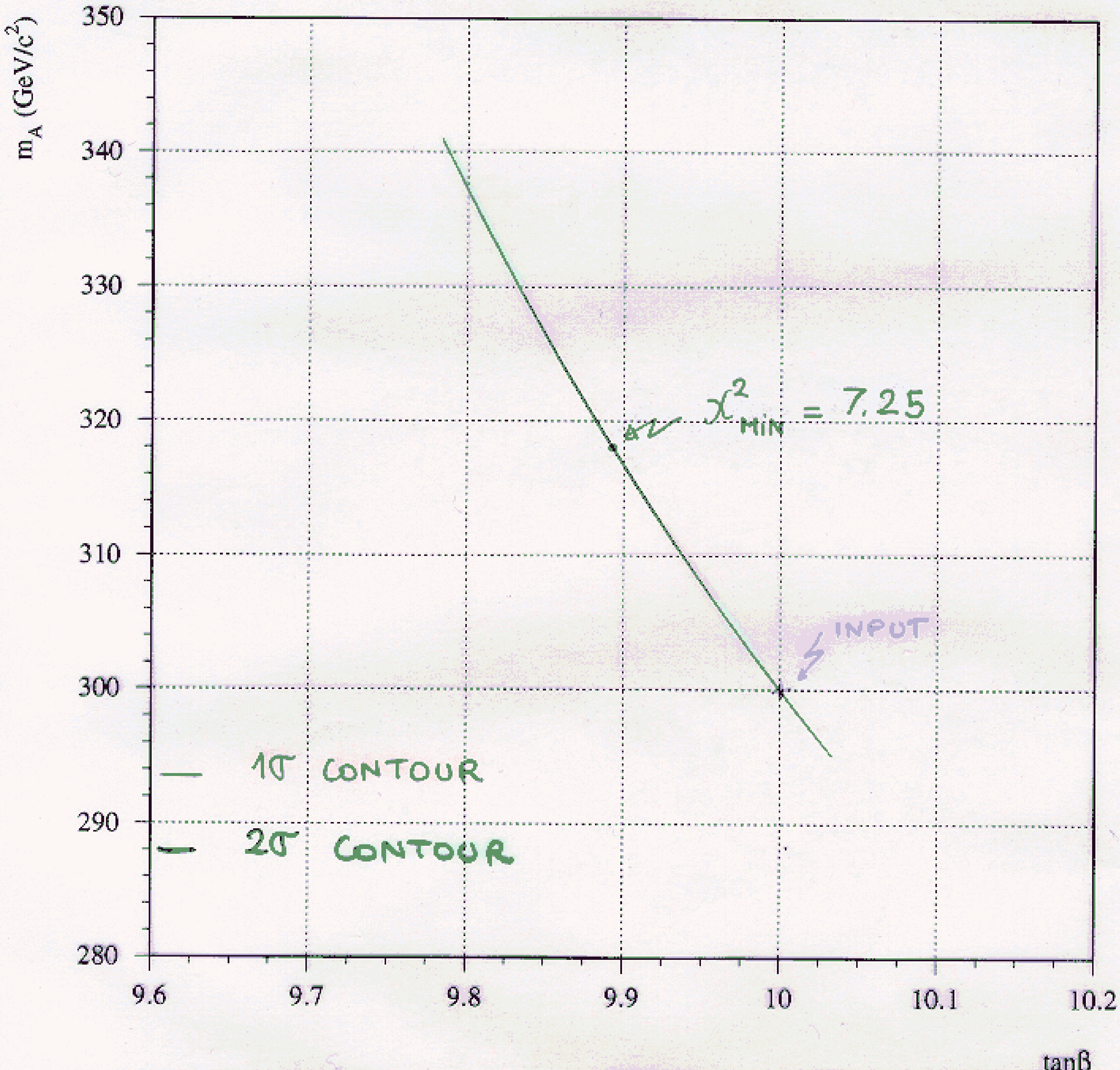
- $\Delta\chi^2$ (SM − MSSM) ≃ 150

- DOMINATED BY (→ STAT. DOMINATED)
  - $\sigma(\mu\mu \to h \to bb)$ — 85
  - $\sigma(e^+e^- \to hZ)\,BR(h \to b\bar{b})$ — 25 (*)
  - Γ_h — 25

(*) IF $\sigma_{m_b} = 0$, 3 OTHERWISE !

ANSWERS :

FIRST ASSUME THAT $A_t = \mu = M_{SUSY} = 1\,TeV$ (INPUT) AND FIT m_A AND $\tan\beta$ FROM ALL EXISTING MEASUREMENTS (LHC + NLC + STANDARD FMC)



1) $\tan\beta = 9.89 \pm 0.06$; $m_A = 317 \pm 11$ GeV

LOOKS NICE

2) $\tan\beta$ AND m_A ARE 100% CORRELATED ⇒ NEED TO MEASURE ONE TO DETERMINE THE OTHER ...

LOOKS BAD

3) UNFORTUNATELY, THE SAME OCCURS (100% CORRELATION) WITH THE OTHER THREE PARAMETERS)

⇒ FOR ≃ ANY VALUE OF ONE OF THE FIVE PARAMETERS ($\tan\beta$, m_A, M_{SUSY}, A_t, μ), IT IS ≃ ALWAYS POSSIBLE TO FIND VALUES FOR THE OTHER FOUR WHICH FIT WITH THE MEASUREMENT.

e.g. $\tan\beta = 5$ ⇝ $m_A = 291$ GeV $\chi^2 = 7.79$
$M_{SUSY} = 4.036$ TeV
$A_t = 1.018$ TeV
$\mu = 0.942$ TeV

$\tan\beta = 15$ ⇝ $m_A = 299$ GeV $\chi^2 = 7.30$
$M_{SUSY} = 1.370$ TeV
$A_t = 0.205$ TeV
$\mu = 1.776$ TeV

$m_A = 250$ GeV ⇝ $\tan\beta = 4.98$ $\chi^2 = 8.00$
$M_{SUSY} = 2.164$ TeV
$A_t = 0.394$ TeV
$\mu = -9.803$ TeV

$m_A = 350$ GeV ⇝ $\tan\beta = 10.22$ $\chi^2 = 7.41$
$M_{SUSY} = 0.757$ TeV
$A_t = 10.043$ TeV
$\mu = 1.563$ TeV

ETC...

⇝ RESULT OF THE FIT

PARAMETER	"STATISTICAL UNCERTAINTY" (*)	INPUT	"SYSTEMATIC UNCERTAINTY" (**)
$\tan\beta$	± 0.06	(10)	$5 \rightarrow 50$
m_A	$\pm 5\%$	(300)	$\pm 20\%$ (ie ± 60 GeV/c^2)
M_{SUSY}	–	(1)	$0.5 \rightarrow 5$
A_t	–	(1)	$-10 \rightarrow +10$
μ	–	(1)	$0 \rightarrow +10$

(*) = M_{SUSY}, A_t, μ FIXED

(**) = ALL PARAMETERS ALLOWED TO VARY

⇒ EVERYTHING IS "SYSTEMATIC DOMINATED", i.e., DOMINATED BY THE CORRELATION BETWEEN THE PARAMETERS, AND THE POSSIBILITY OF FINE TUNING THEM TO REACH THE SAME FIT QUALITY. (i.e., THE SAME PREDICTION FOR ALL OBSERVABLES)

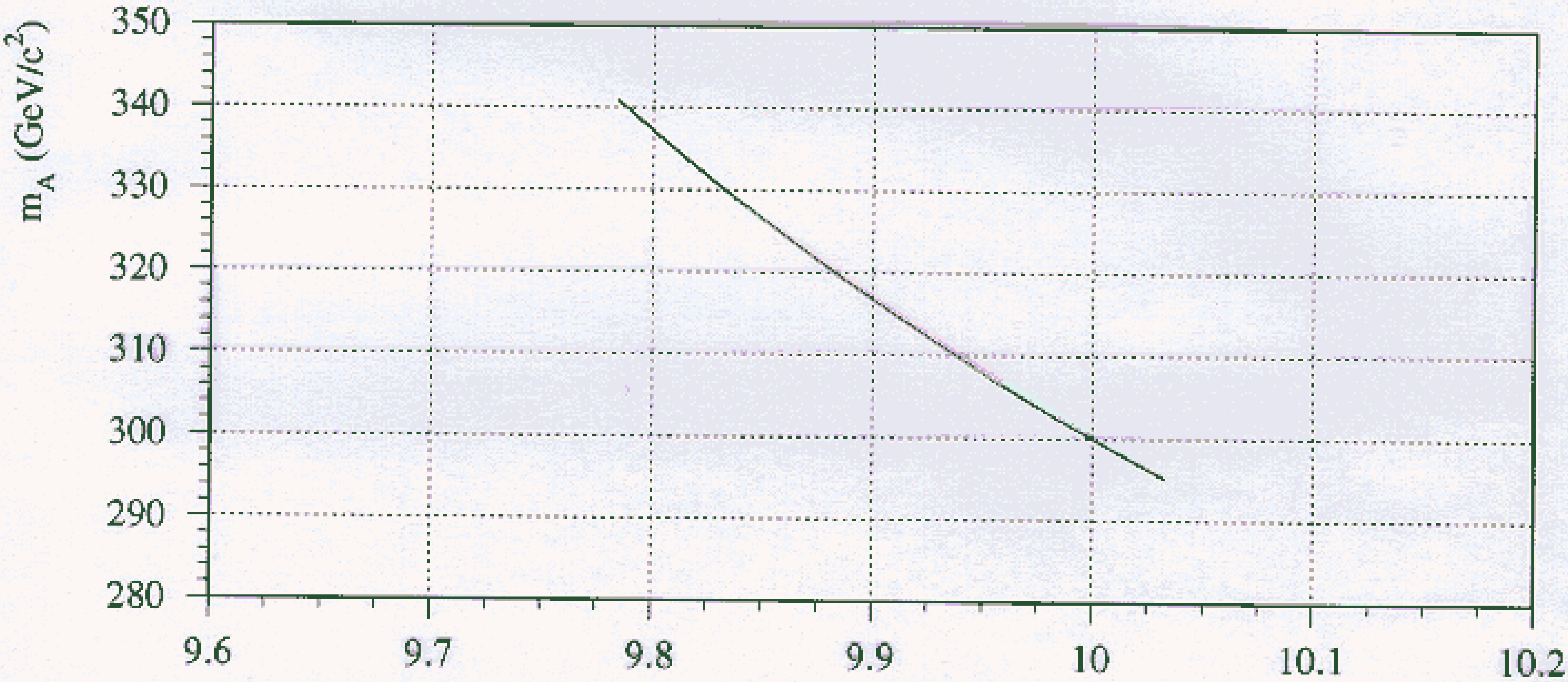
QUESTION: IS THE SYSTEMATIC UNCERTAINTY FUNCTION OF THE STATISTICAL ACCURACY OF THE MEASUREMENTS ?

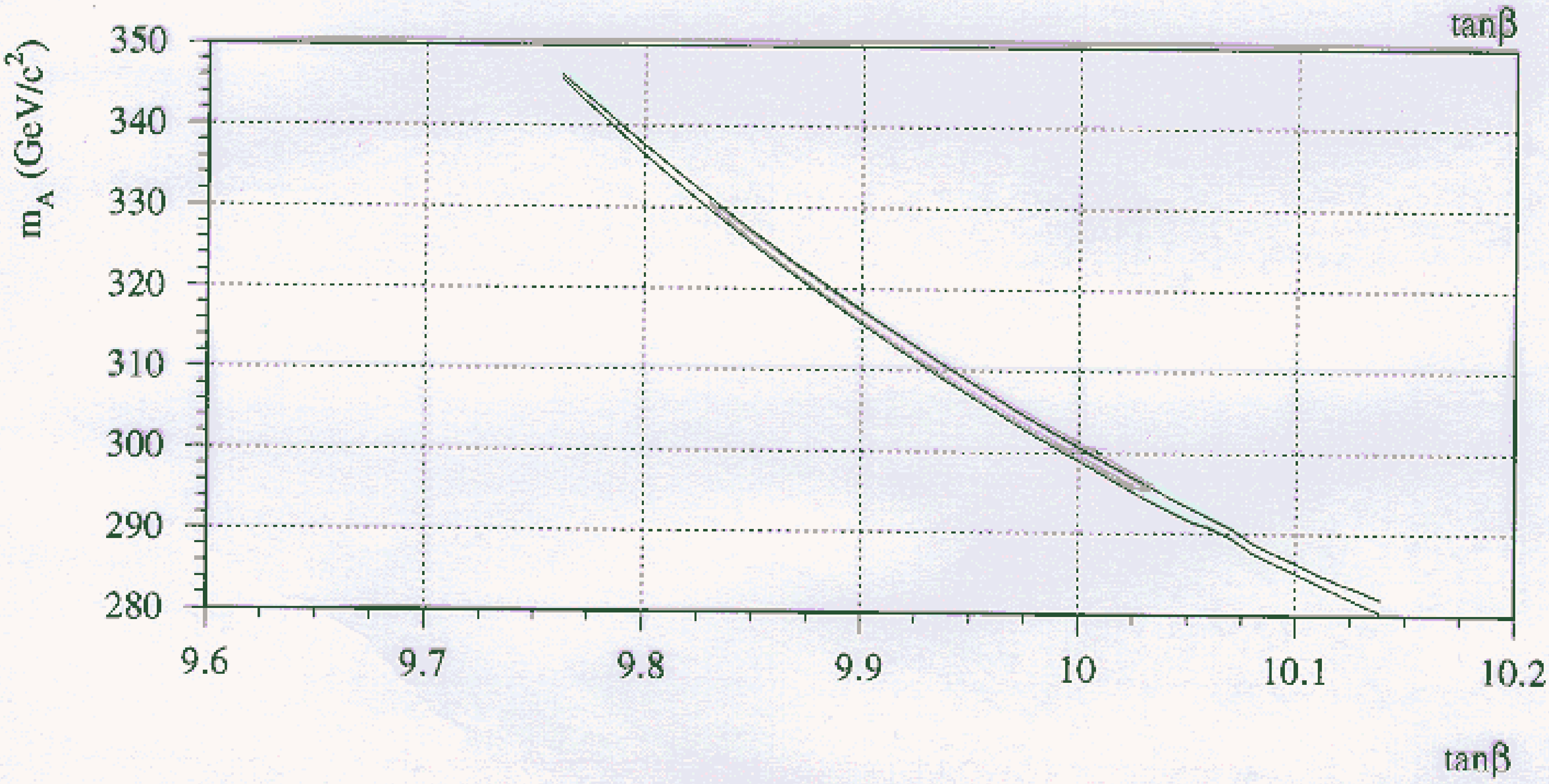
e.g.

$\sigma(m_h) = 1\ GeV/c^2$

INSTEAD OF $0.1\ MeV/c^2$

($100\ MeV/c^2$ WOULD HAVE MADE NO VISIBLE MODIFICATIONS)





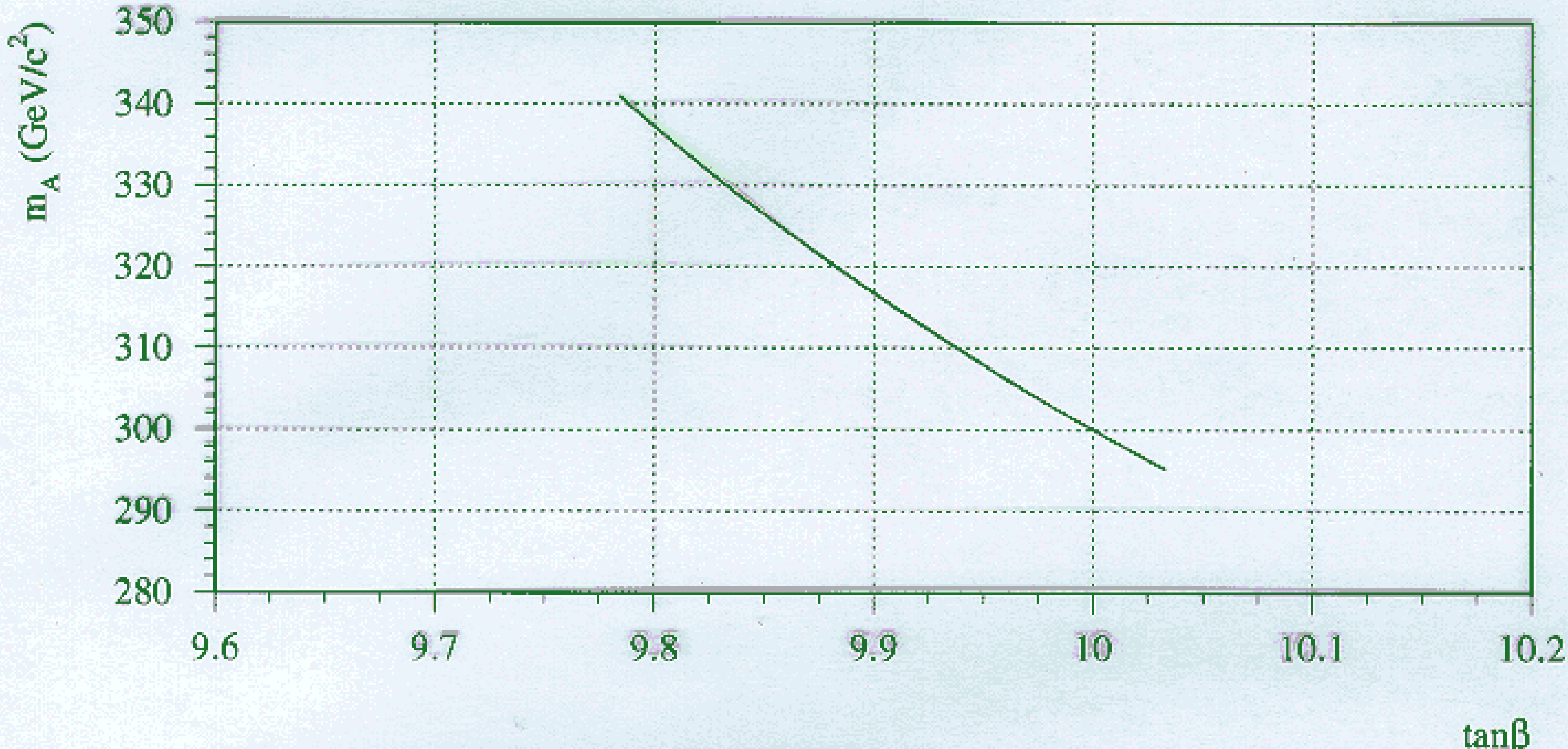
$\sigma_{\tan\beta}$: 0.06 → 0.10

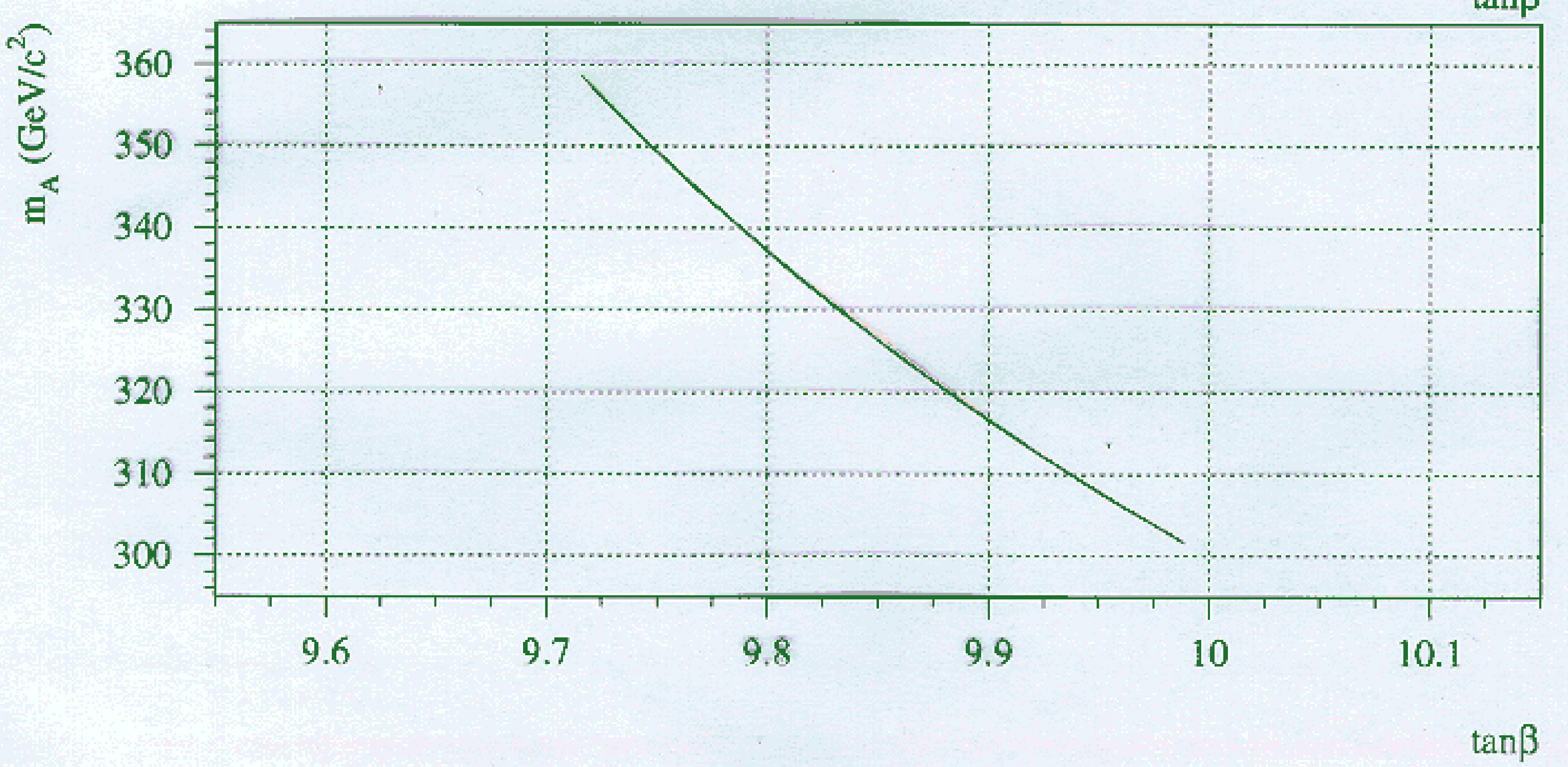
σ_{m_A} : 11 GeV → 16 GeV

– NO CHANGES ON THE SYSTEMATICS

$\sigma(\Gamma_h) = 100$ MeV (AS OF LHC)

INSTEAD OF 0,5 MeV



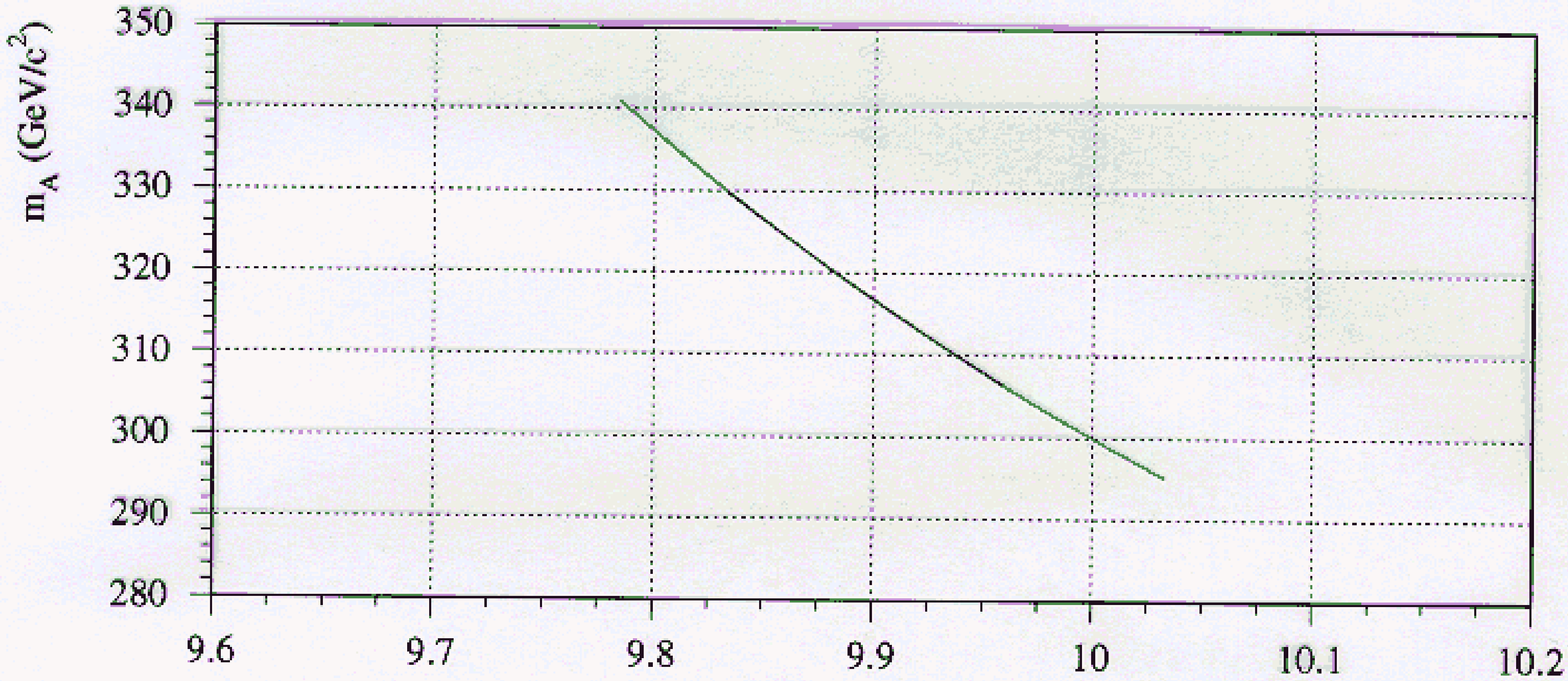


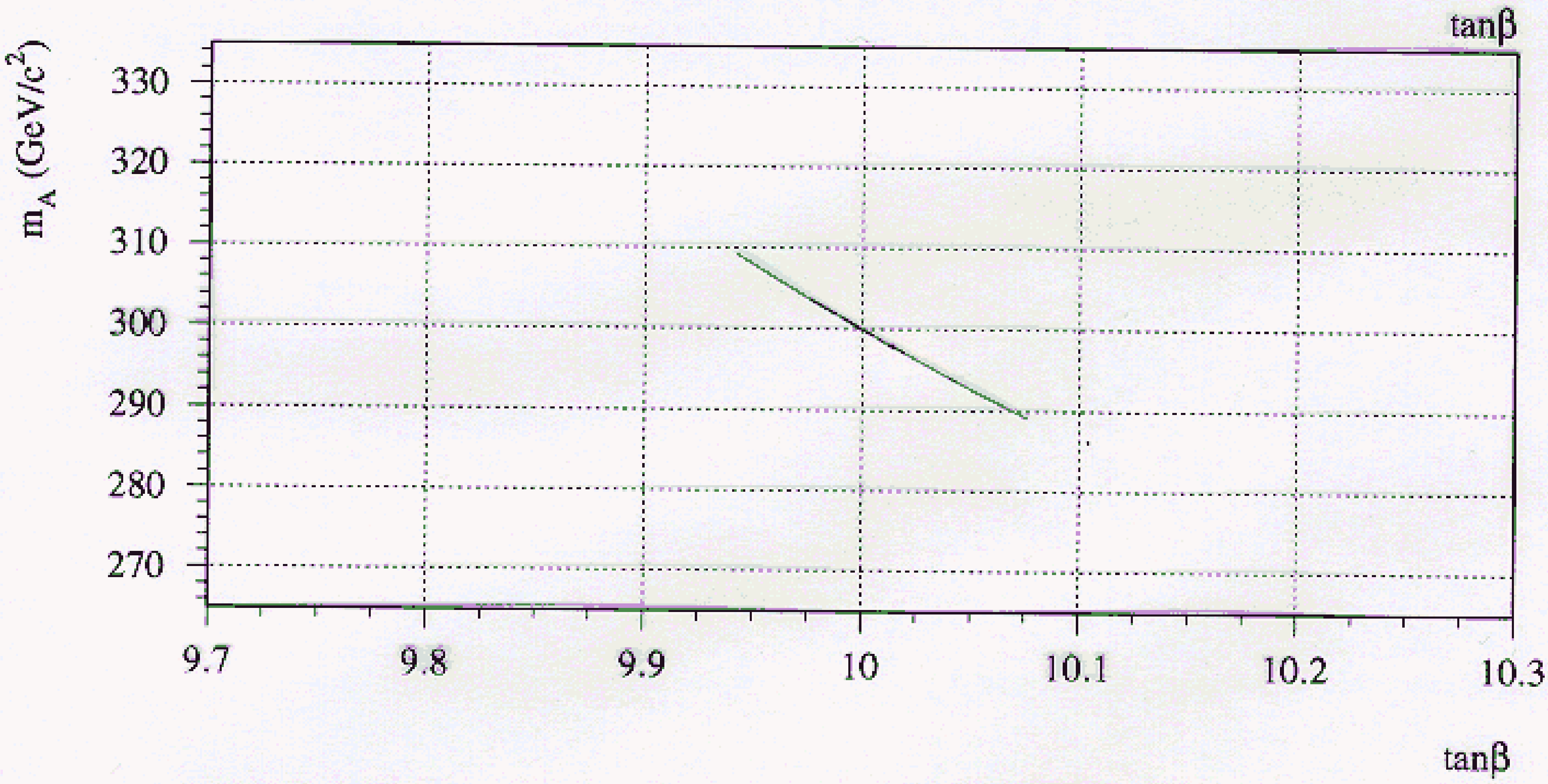
- $\sigma_{\tan\beta}$: 0.06 → 0.07
  σ_{m_A} : 11 GeV → 13 GeV

- NO CHANGES ON THE SYSTEMATICS

$\Gamma(\Gamma_h) = 0.1$ MeV (OUTSTANDING FMC)

INSTEAD OF 0.5 MeV



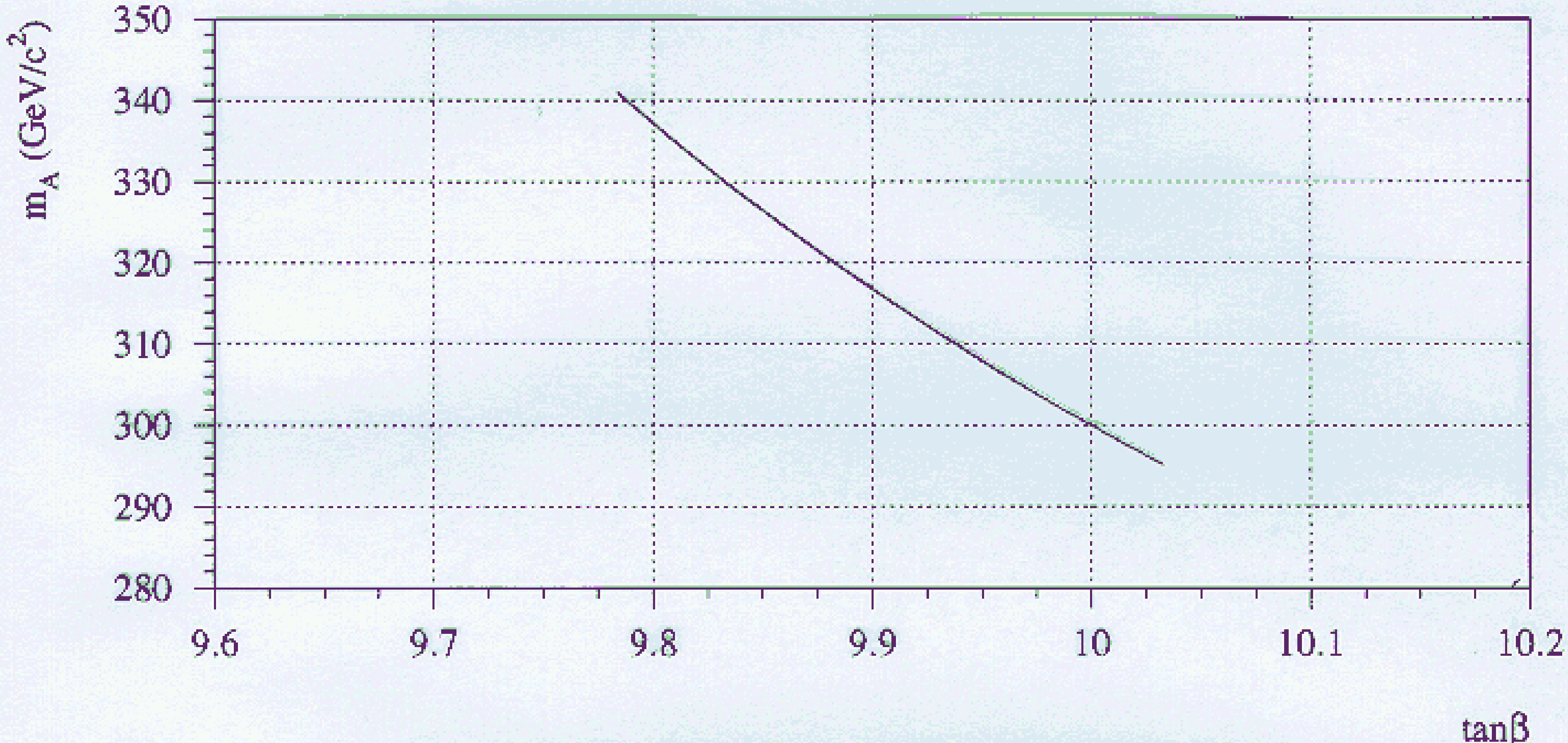


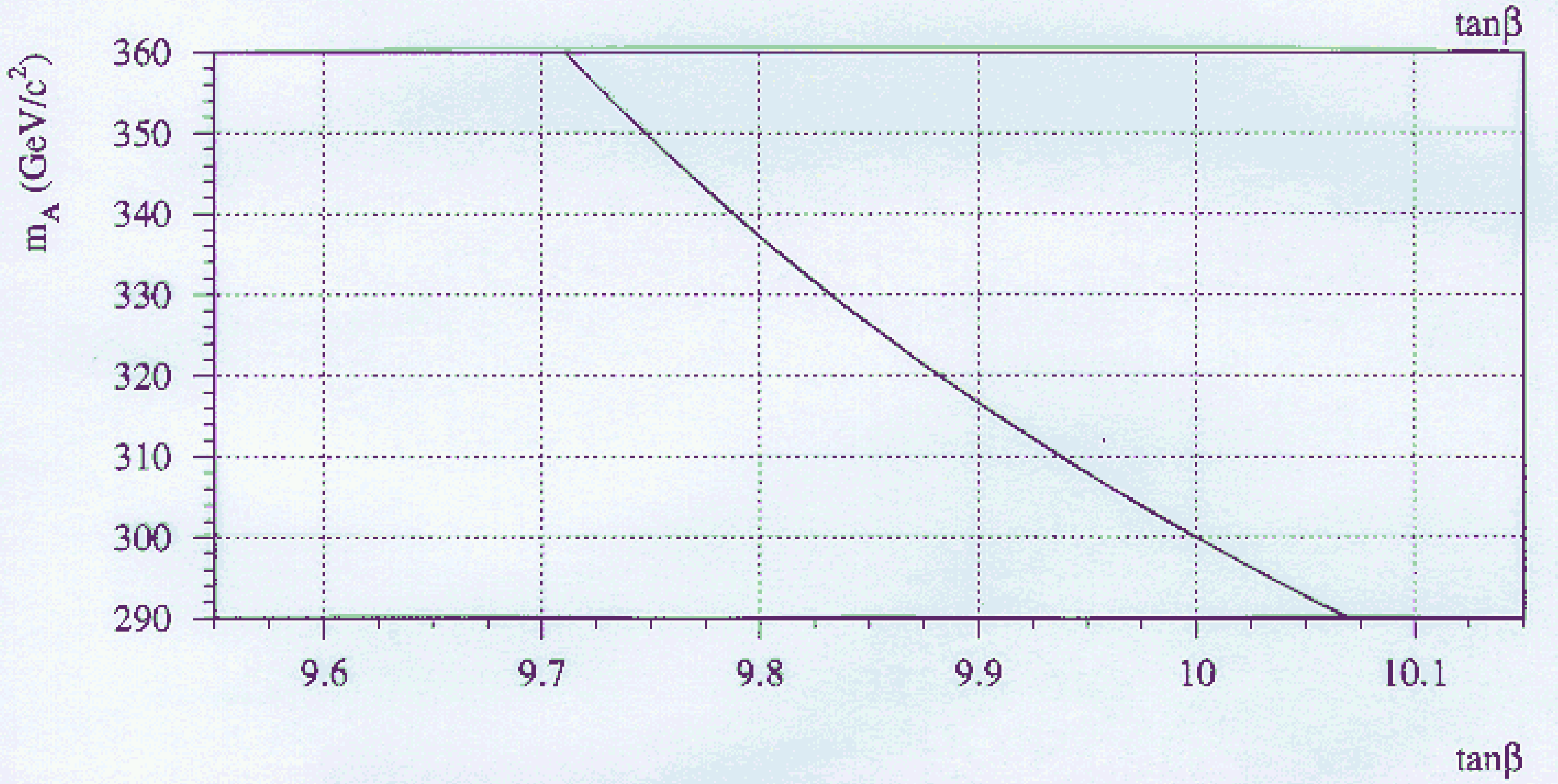
- $\Gamma_{\tan\beta}$: 0.06 → 0.03
  Γ_{m_A} : 11 GeV → 5 GeV

- NO CHANGES IN THE SYSTEMATICS

$\sigma(\sigma(\mu\mu \to h \to b\bar{b})) = 10$ pb ($1 pb^{-1}$ @ FMC)

INSTEAD OF 1 pb ($100 pb^{-1}$ @ FMC)





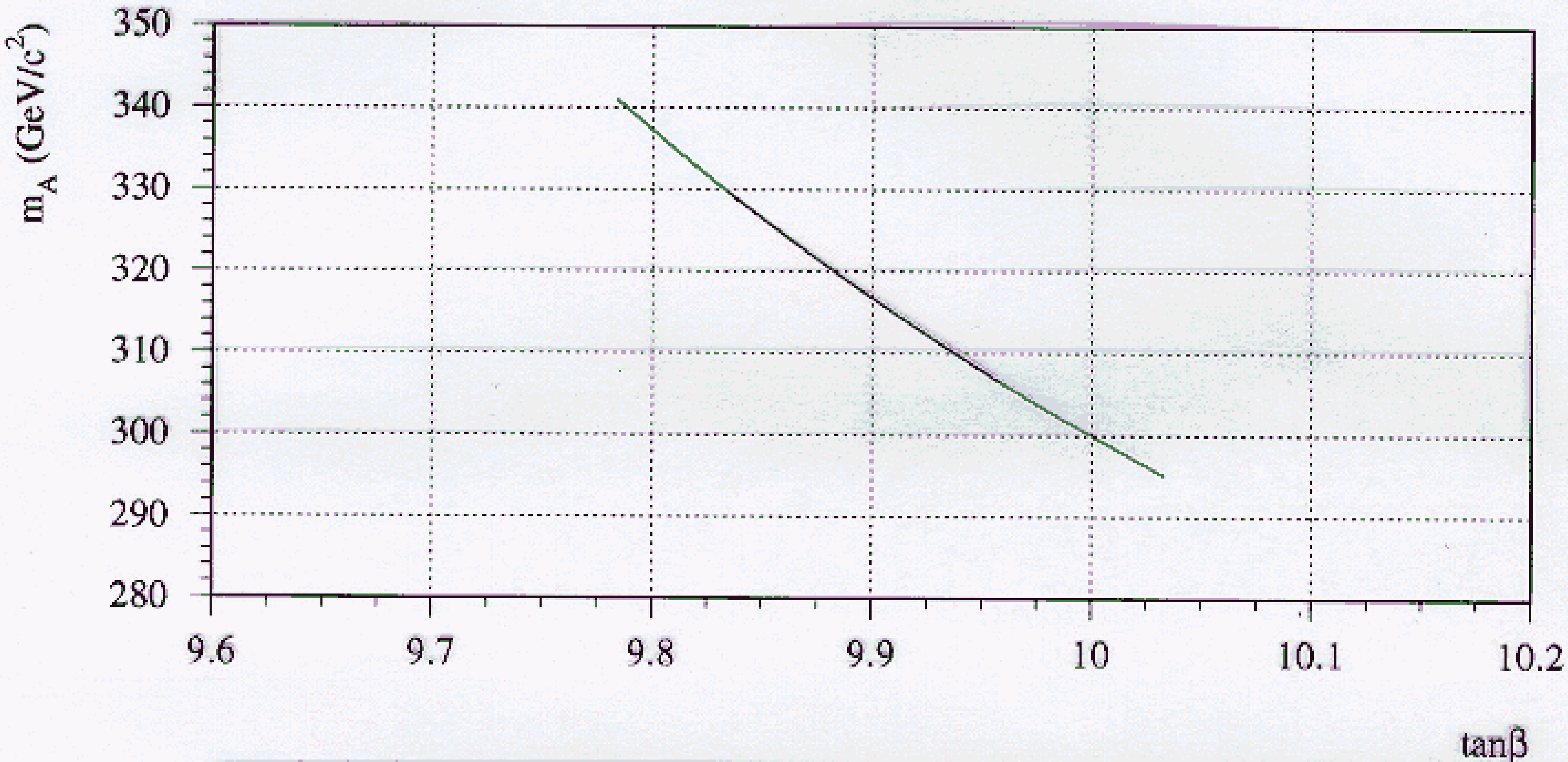
- $\sigma_{\tan\beta}$: 0.06 → 0.12
  σ_{m_A} : 11 GeV → 22 GeV

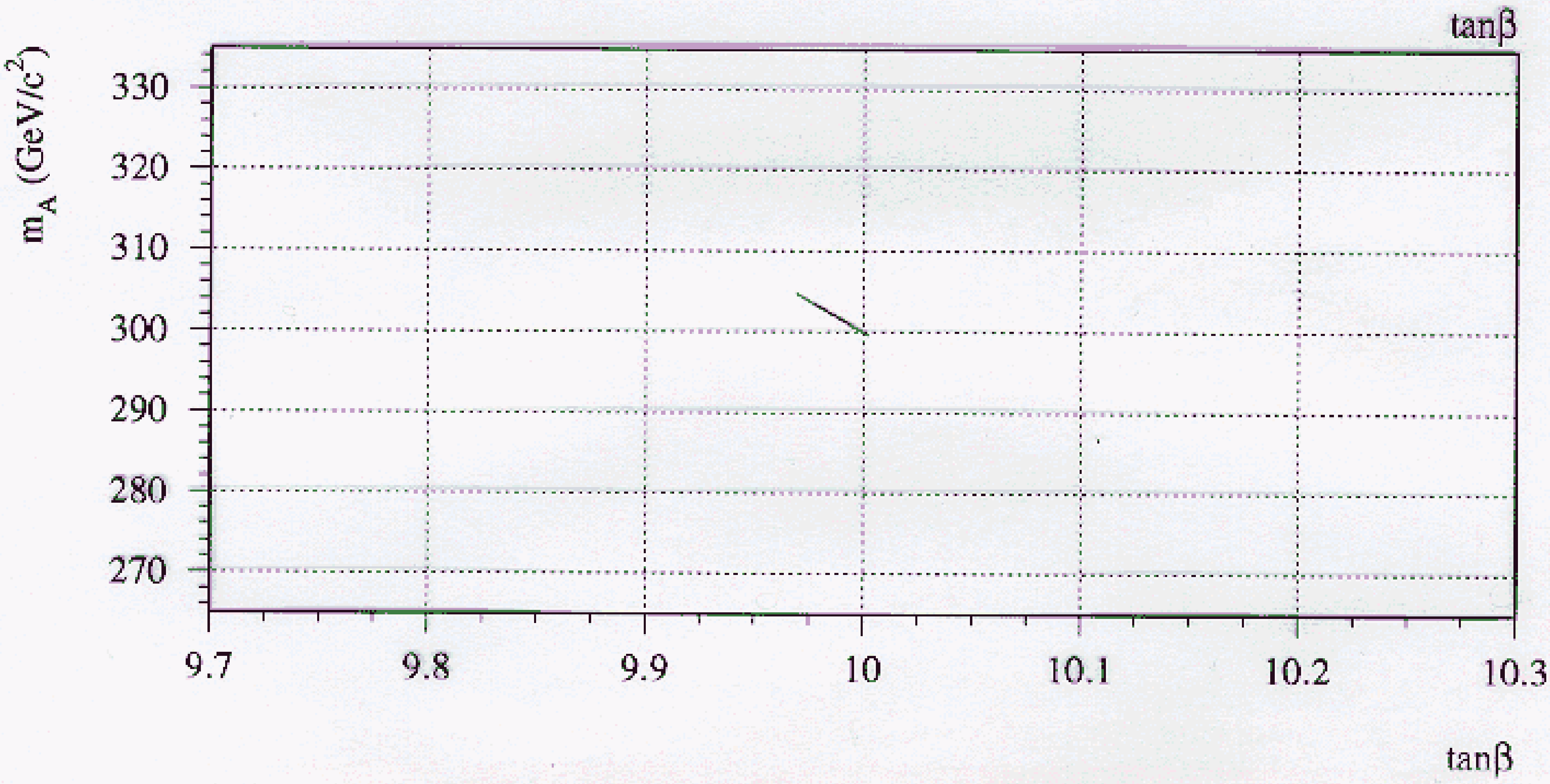
- NO CHANGES IN THE SYSTEMATICS

$\sigma(\sigma(\mu^+\mu^- \to h \to b\bar{b})) = 0.1$ pb (10 fb^{-1} @ FMC)

INSTEAD OF 1 pb (100 pb^{-1} @ FMC)

NEEDS $\sigma_{m_b^{POLE}} \ll 0.5\%$

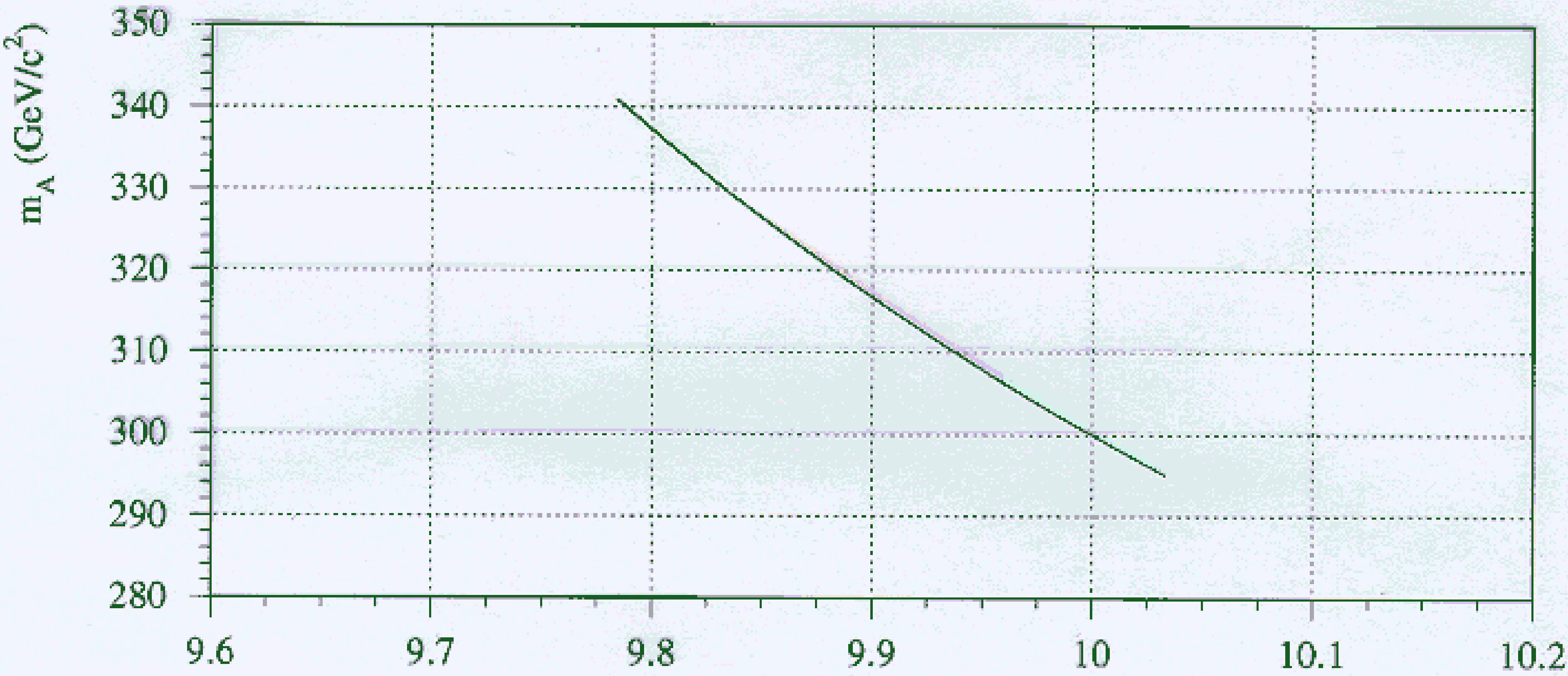


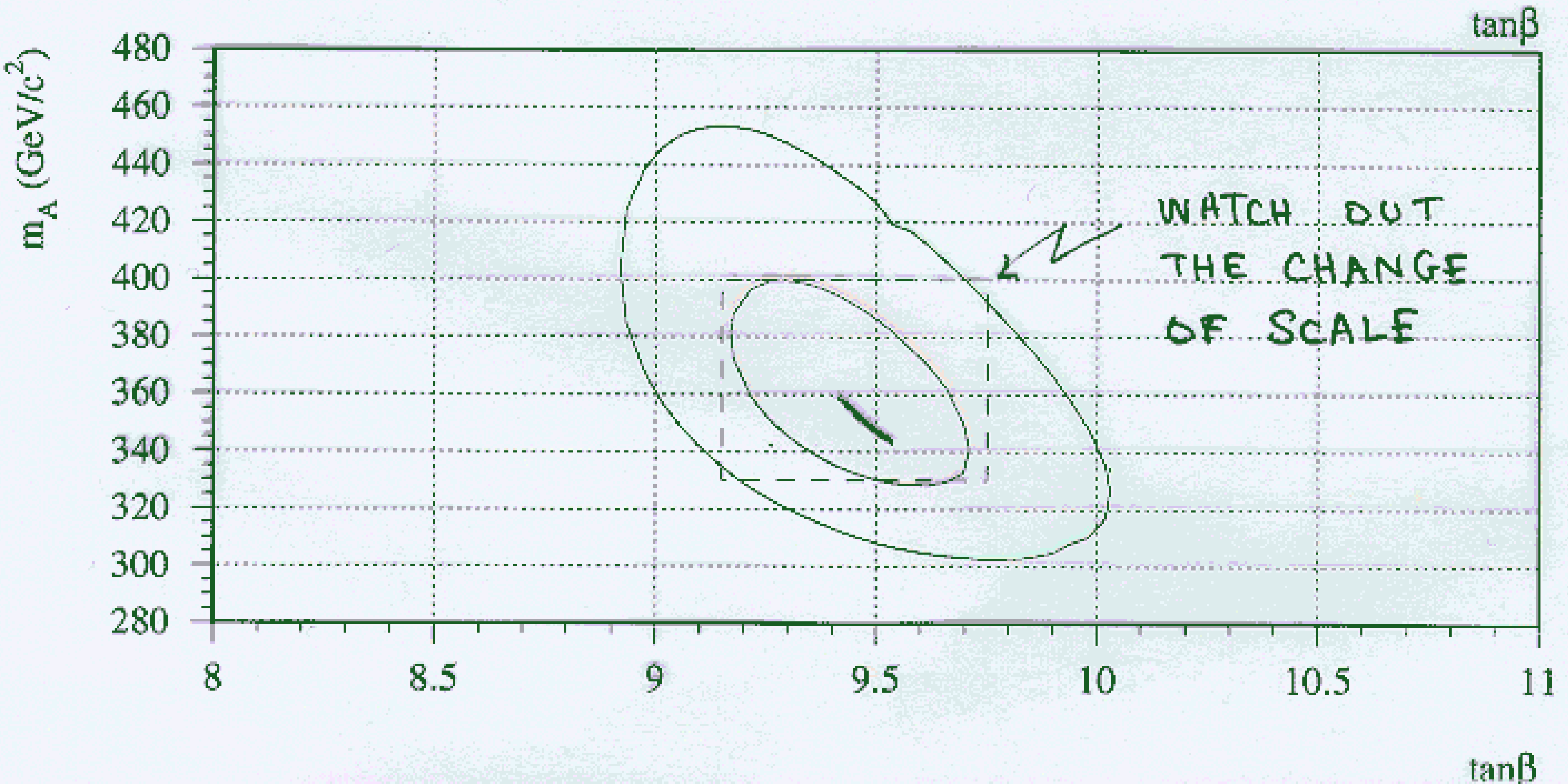


- $\sigma_{\tan\beta}$: 0.06 → 0.09
  σ_{m_A} : 11 GeV → 1.5 GeV
- NO CHANGES ON THE SYSTEMATICS

NO $\mu^+\mu^-$ COLLIDER !?

$$\rightarrow \begin{cases} \sigma(m_H) = 100 \text{ MeV}/c^2 \\ \sigma(\Gamma_H) = 100 \text{ MeV}/c^2 \\ \sigma(\mu\mu \rightarrow H \rightarrow bb) \text{ NOT MEASURED} \end{cases}$$

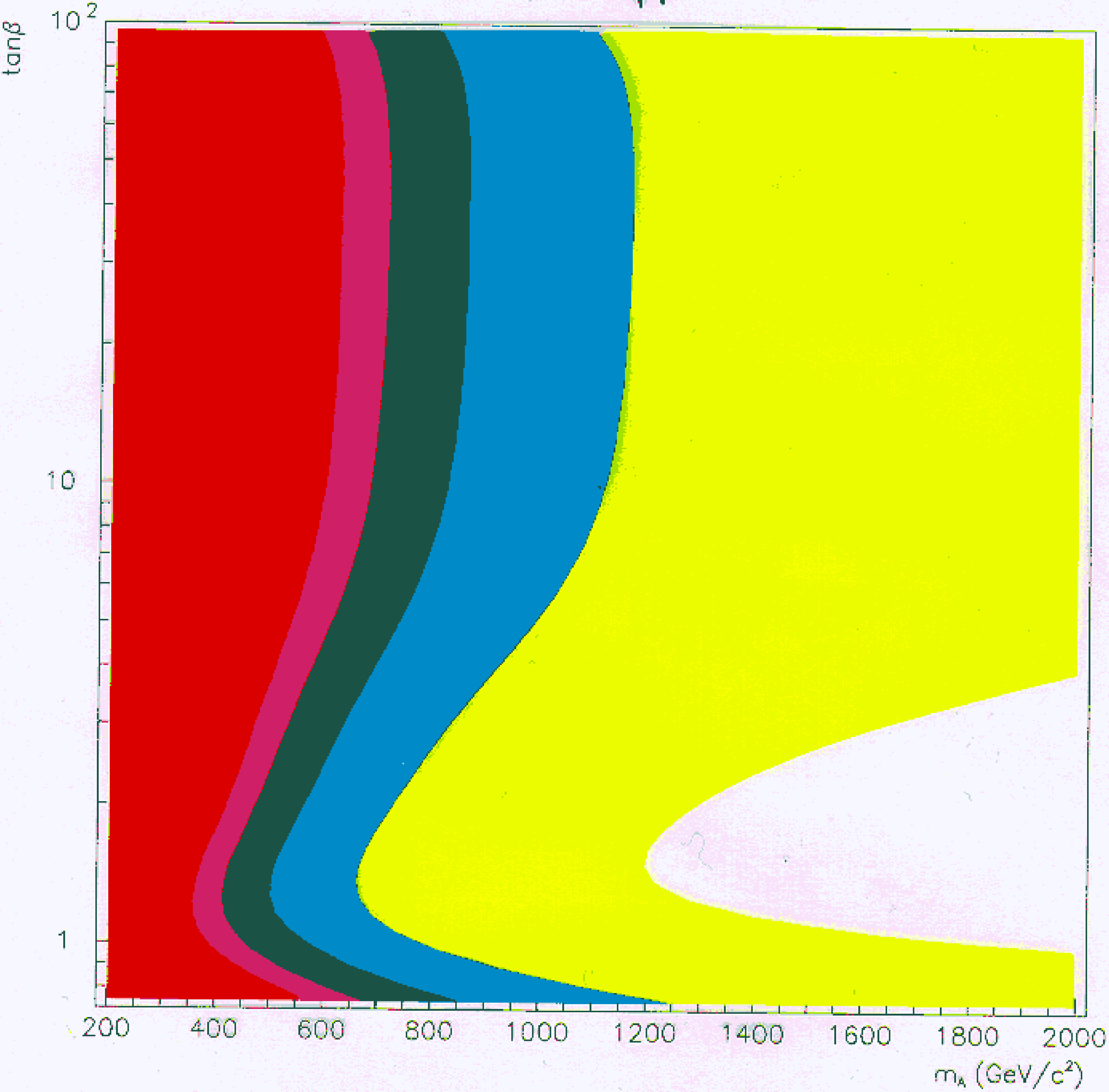




- $\begin{cases} \sigma^{STAT}_{\tan\beta} : 0.06 \rightarrow 0.50 \\ \sigma^{STAT}_{m_A} : 11 \text{ GeV} \rightarrow 40 \text{ GeV} \end{cases}$

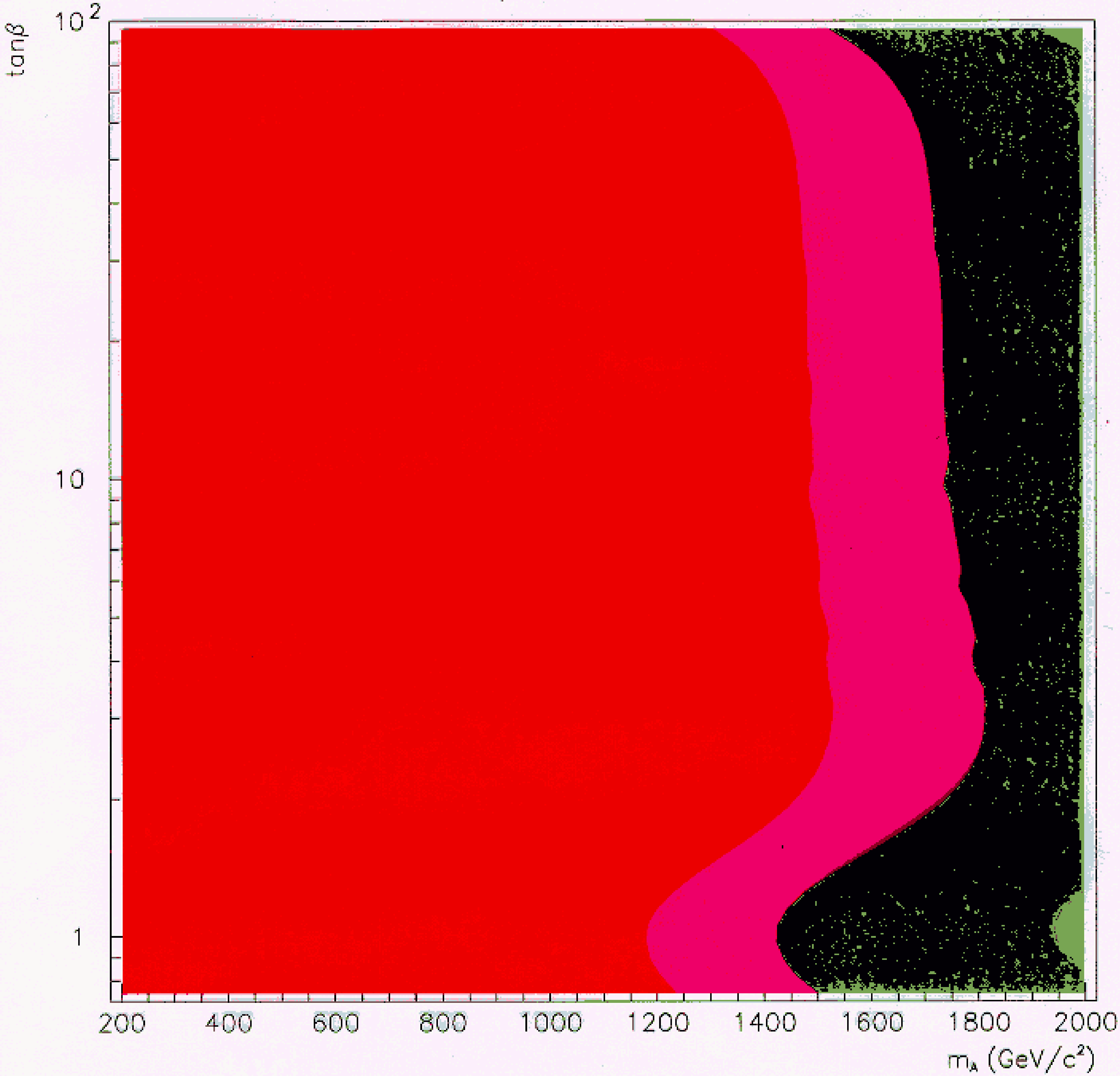
- SYSTEMATICS OUT OF CONTROL (χ^2 FLATISH, SECONDARY MINIMA EVERYWHERE ...)

MAXIMAL MIXING, $\mathcal{L}_{\mu\mu} = 100\,pb^{-1}$



3σ SENSITIVITY FOR m_A VALUES UP TO 600 – 800 GeV/c^2

MAXIMAL MIXING, $\mathcal{L}_{\mu\mu} = 10\ fb^{-1}$



3σ SENSITIVITY TO $m_A \lesssim 2000\ GeV/c^2$!