

Higgs at JLC phase-I

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- 1. Introduction of Higgs Physics at Phase-I**
- 2. Summary of Results so far / Updated Results**
- 3. What to do for ACFA Report**
- 4. Summary**

Higgs @ JLC Phase-I

BIG THINGS to come !

1. Don't give up DISCOVERY !

First DISCOVERY may come from us!

if LEP-II, Tevatron could not,

LHC needs years for analyses.

WE NEED ONLY 1 DAY for DISCOVERY !

2. Even just with Higgs Mass determination:

if $M_h > 140 \text{ GeV}$; MSSM dead

$M_h > 210 \text{ GeV}$; SUSY dead

$M_h > 200 \text{ GeV}$; SM dead

3. Just from cross-section measurements:

if $\sigma < \sigma_{\min}$; New Physics

between EW and GUT.

4. Just from Branching Ratio Measurements:

if $\text{Br}(h \rightarrow bb)/\text{Br}(h \rightarrow \tau\tau) \neq m_b^2/m_\tau^2$

SM / MSSM/ all Type-II Higgs Model dead.

5. From precise measurements

we can measure $\tan\beta$, α , A^0 , H^0 , H^\pm mass etc..

Un official

LEP II running @ 208 GeV Now

Situation now = exciting!

☆ So far sensitive mass < 113 GeV

☆ "candidates" @ ~ 115 GeV!
A.D.L.O

by the end of September

→ 2.5 - 30 ?

Important dates

1. 20-July LEPC ⇒ got 2 week extension.
1-Oct: current plan to stop LEP
2. 11-Aug (today)
Spokesmen + Cashmore private meeting...
3. 5-Sep LEP seminar
↳ ~ final decision.
4. Xmas extension ??

Future branches

optimistic? → pessimistic?

Q. LEP 112 GeV candidates "real"?

Yes

extend LEP runs initially by ~20-Dec '00

extend more

stop LEP for LHC

Y2001

Y2002

Y2003

20

WNT

Y2004

Y2005

Y2006

Y2007

Y2008

Y2009

Y2010

NO

stop LEP on 1-Oct '00

exclude up to 112-117 GeV

Transition Run 2

exclude up to 150 GeV

30 indicators?

Don't wait!

indicators

exclude up to 190 GeV

start construction 200 GeV

LHC phase-I

indicators?

Discovery

start operation

1 day

Higgs factory

definit answer to

OUT ?

ZUZ ?

great!

great!!

if nothing = big discovery

0105-2010

So,,,

This year - Year 2003

highly possible to hear news

from LEP, Tevatron for

Higgs signal indication.

We have to be **READY**

to construct JLC at any time.

Physics Values and Measurements (Phase-I)

1. Higgs gauge coupling, total width

$$\sigma_{hZ} \propto \left| \begin{array}{c} \text{Z} \\ \text{---} \\ \text{h} \\ \text{---} \\ \text{Z} \end{array} \right|^2 \propto \left| \begin{array}{c} \text{W} \\ \text{---} \\ \text{h} \\ \text{---} \\ \text{W} \end{array} \right|^2$$

$$\propto \Gamma_{h \rightarrow WW^*} \quad (= \text{Br}(h \rightarrow WW) \times \Gamma_{\text{tot}})$$

$$\begin{aligned} \therefore \Gamma_{\text{tot}} &= \eta / \eta^{\text{SM}} \times \Gamma_{\text{tot}}^{\text{SM}} \\ \eta &= \sigma_{hZ} / \text{Br}(h \rightarrow WW^*) \end{aligned}$$

2. Yukawa coupling Model independent

$$\left| \begin{array}{c} \text{f} \\ \text{---} \\ \text{h} \\ \text{---} \\ \text{f} \end{array} \right|^2 \propto \Gamma_{h \rightarrow ff} = \Gamma_{\text{tot}} \times \text{Br}(h \rightarrow ff)$$

$$\begin{aligned} \therefore \left| \begin{array}{c} \text{f} \\ \text{---} \\ \text{h} \\ \text{---} \\ \text{f} \end{array} \right|^2 &= \xi / \xi^{\text{SM}} \times \left| \begin{array}{c} \text{f} \\ \text{---} \\ \text{h} \\ \text{---} \\ \text{f} \end{array} \right|_{\text{SM}}^2 \\ \xi &= \frac{\text{Br}(h \rightarrow ff)}{\text{Br}(h \rightarrow WW^*)} \sigma_{hZ} \end{aligned}$$

MSSM (type-II 2HDM) specific

β : $\tan\beta = v_2/v_1$

α : Higgs mixing angle

$$\sigma_{hZ} \propto \sin^2(\alpha - \beta)$$

$$\Gamma_{h \rightarrow WW} \propto \sin^2(\alpha - \beta)$$

$$\Gamma_{h \rightarrow bb} \propto (\sin \alpha / \cos \beta)^2 m_b^2 \quad (\text{and } \tau)$$

$$\Gamma_{h \rightarrow cc} \propto (\cos \alpha / \sin \beta)^2 m_c^2$$

↑
~ 10 % error for running m_c @ 100 GeV

**Many measurements can be used
to determine MSSM parameters**

→ **A, H mass,
Higgs gauge coupling
Yukawa coupling**

What's done so far

1. Check discovery potential (very conservatively)

→ use OPAL full simulation

→ need only $\ll 3 \text{ fb}^{-1} \leftarrow 1 \text{ day operation.}$

2. Check $e^+e^- \rightarrow HZ$ measurement sensitivities.

→ use JSF simulator → plots.

→ \star Yukawa-coupling absolute strength

$\sim \delta = 5\%$ in ~ 2 years

$\star \Gamma_H$ total width $\delta = 5\%$ "

$\star HZZ$ (HWW) coupling $\delta \sim 3\%$ "

$\star Br$ measurements for (K. Ishii LCWS '99)

$H \rightarrow \underline{WW}, \underline{bb}, \underline{\tau\tau}, \underline{cc}, \underline{gg}$

↳ (I. Nakamura LCWS '99)

↳ Alister's talk.

3. Check possible problems

→ use JIM, JSF, simple simulation

→ \star beamstrahlung effects (I. Ueda LCWS '99)

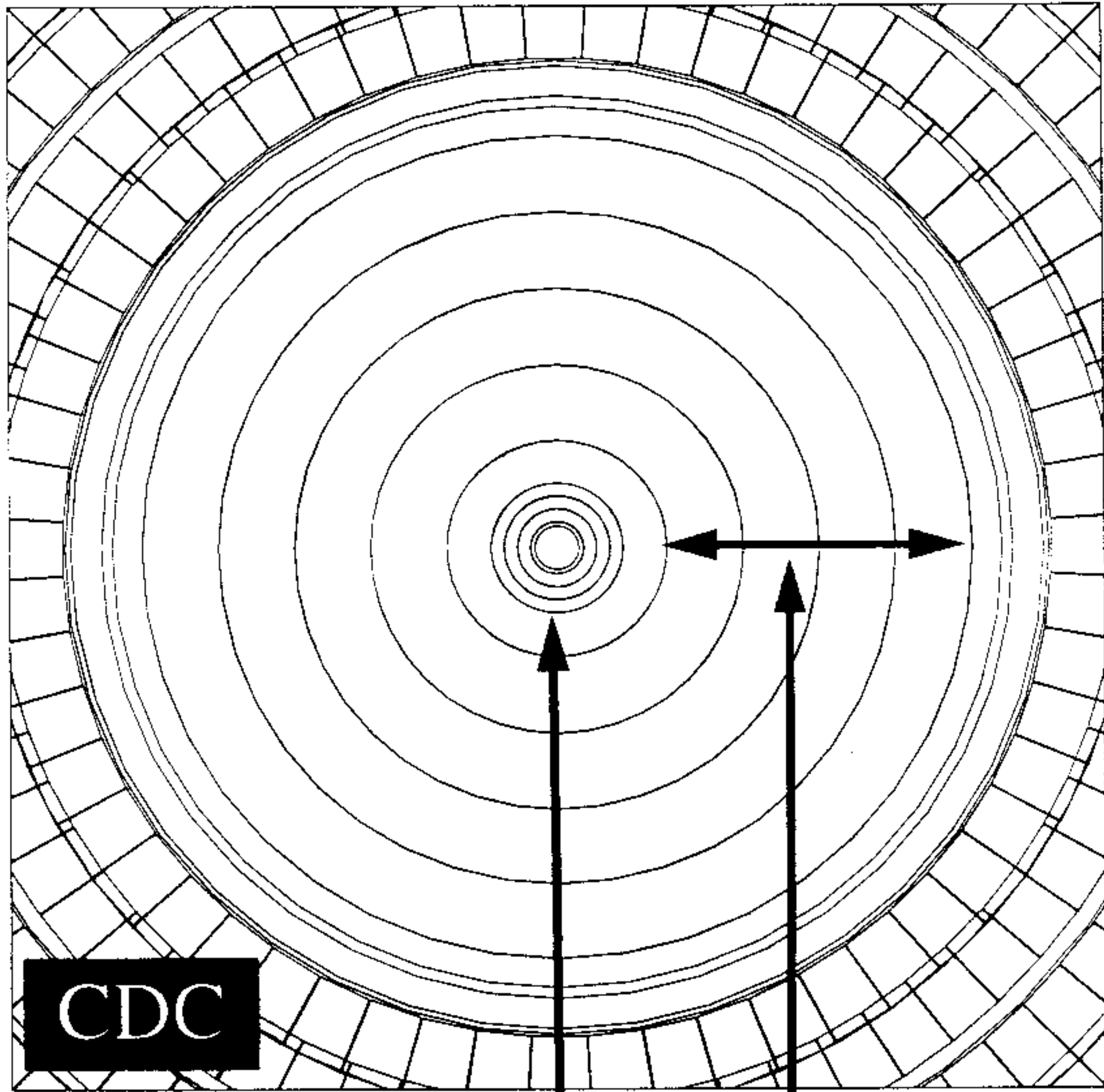
\star two-photon overlap

\star incoherent e^+e^- pairs (J. Kanzaki et al)

→ feed back to detector design. (ACFA LC '99)

intermediate trackers (H.J. Kim et al)

2T \rightarrow 3T (Tanchi et al)



$r = 450 - 2300 \text{ mm} \quad |z| < 2300 \text{ mm}$
 $\sigma_{r\phi} \sim 100 \mu\text{m} \quad \sigma_z \sim 1 - 3 \text{ mm}$

R&D results '98
 $\sigma_{r\phi} \sim 85 \mu\text{m}$ with baby chamber
 (JLC CDC subgroup)

5 Intermediate Tracker

(H. J. Kim et al)
 $r = 100 - 380 \text{ mm} \quad |\cos \theta| < 0.9$
 $\sigma_{r\phi} \sim 20 \mu\text{m} \quad \sigma_z \sim 20 \mu\text{m}$
 300 μm thick Si x 5 layers
 (assumption)

4 layer SiVTX (CCD)

$r = 24 - 60 \text{ mm} \quad |\cos \theta| < 0.9 \quad 330 \mu\text{m}$ thick x 4 layers
 $\sigma \sim 5 \mu\text{m}$

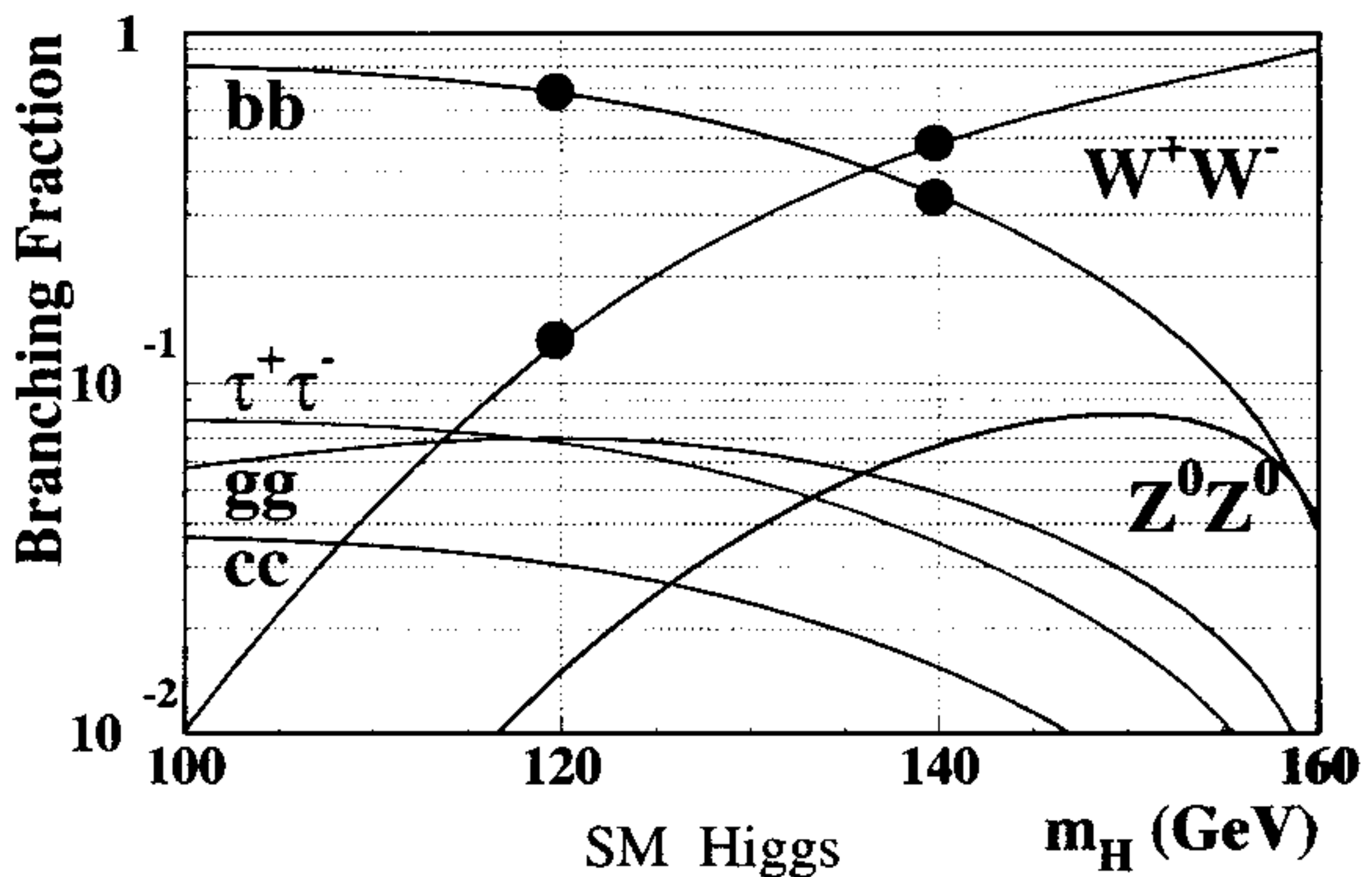
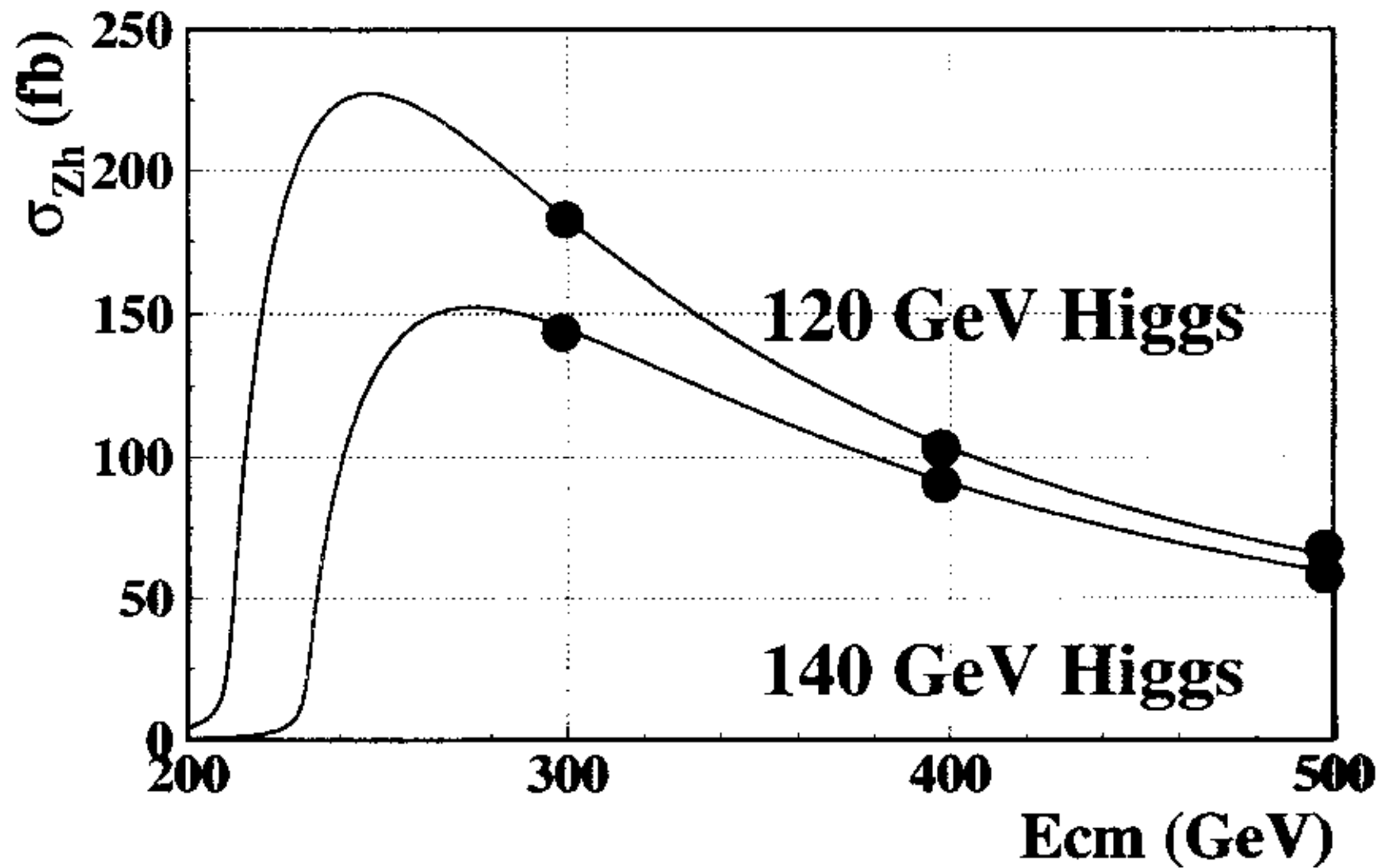
beam test results at KEK '98.
 $\sigma = 3 \mu\text{m}$ (JLC VTX subgroup)

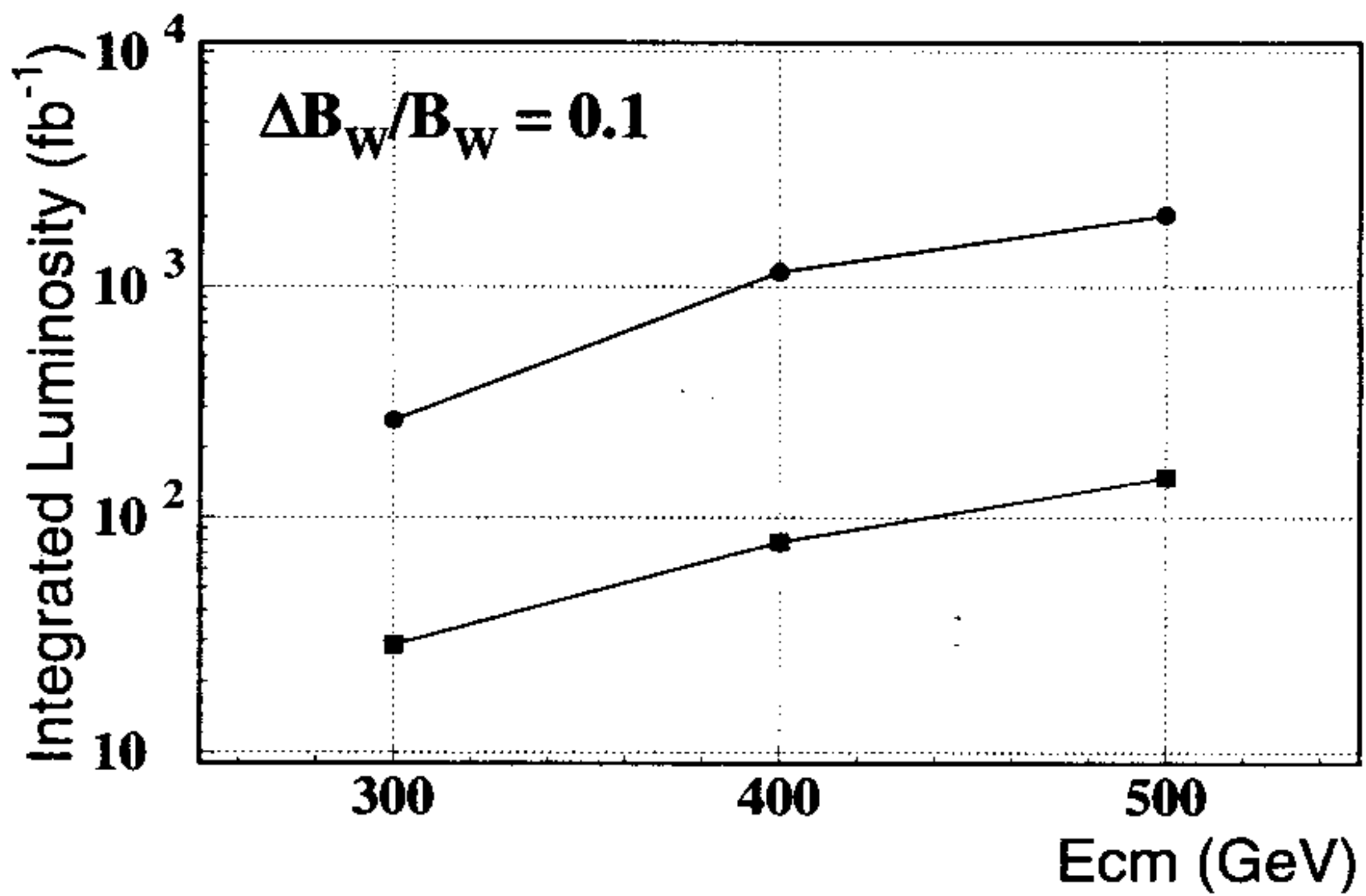
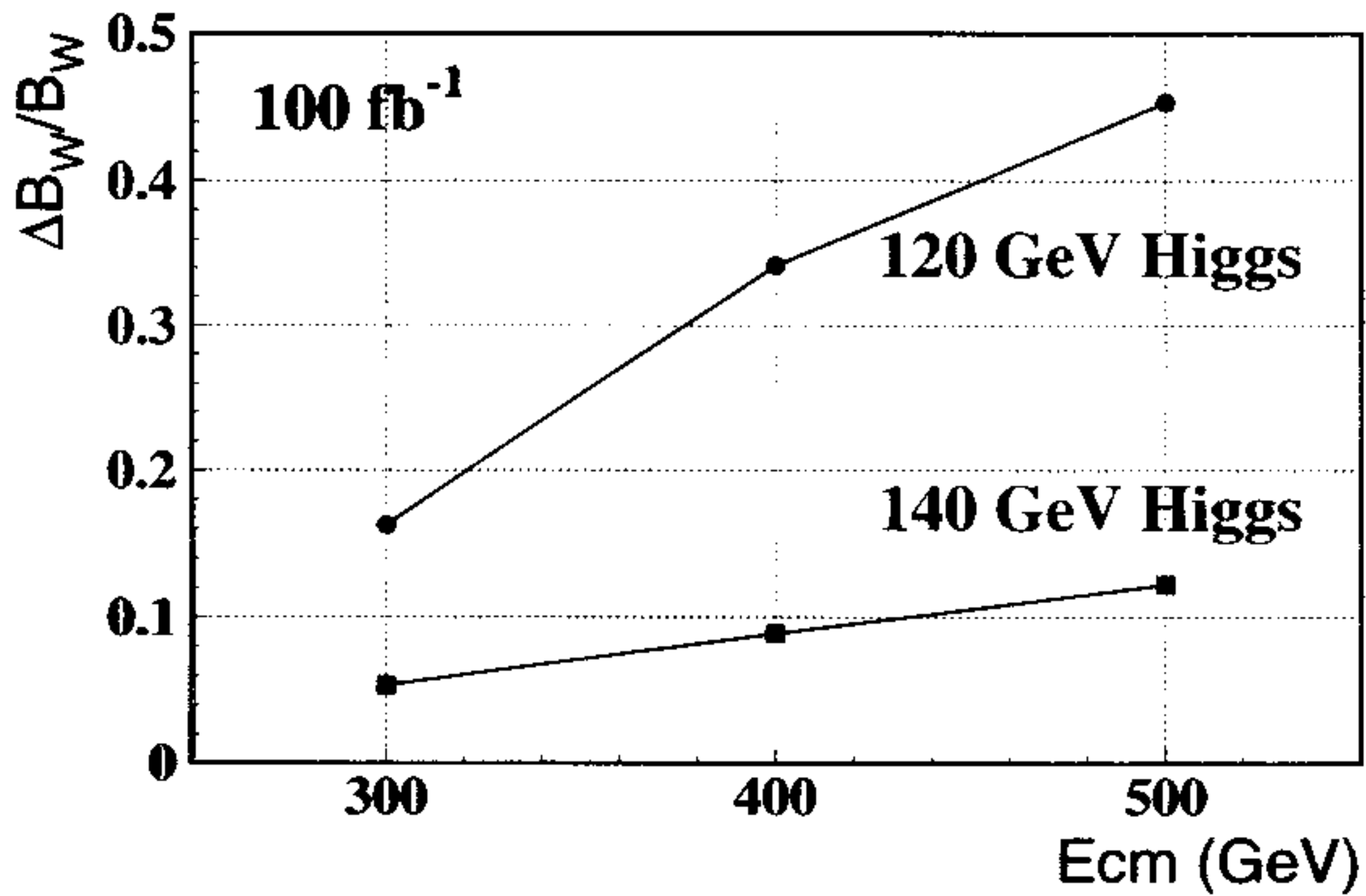
Sensitivity check

Higgs Mass = 120, 140 GeV

Ecm = 300, 400, 500 GeV

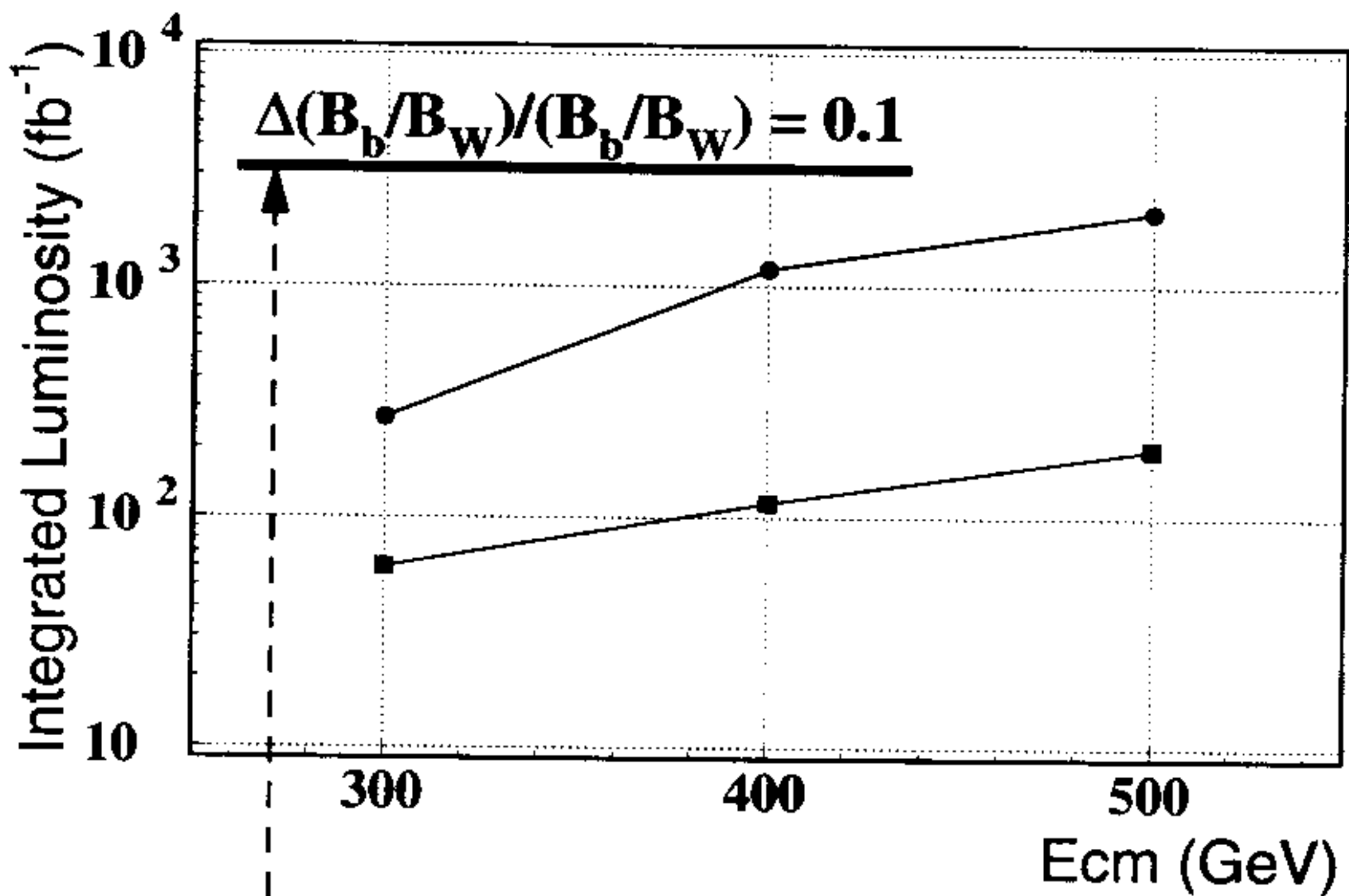
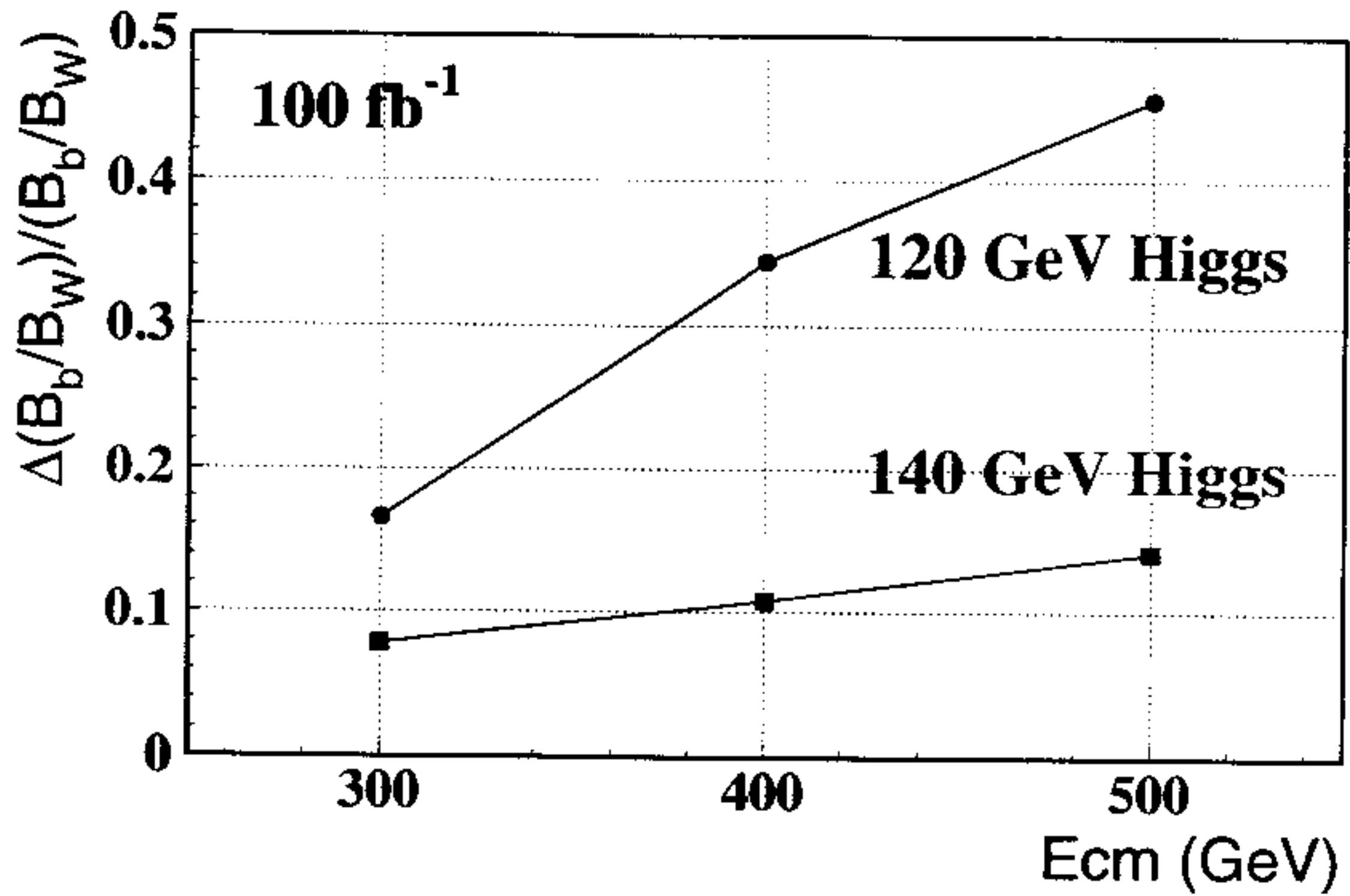
JSF (simdst) + beamstrahlung





Total Higgs width measurement stat error ~ 5 %

Yukawa coupling



Yukawa coupling measurement stat error $\sim 5\%$

Error from b-quark (running) mass is similar size
systematic error ----> theory, α_s

For main mode $e^+e^- \rightarrow HZ$ production
 initial studies ~ demonstration phase
 = almost Done

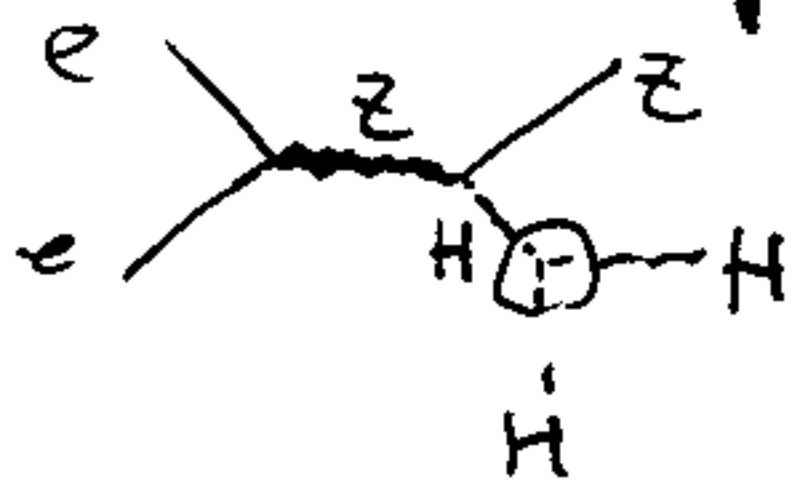
→ to be written

What's NEXT

2 big physics + uncovered topics

World-wide
 + students
 + ...

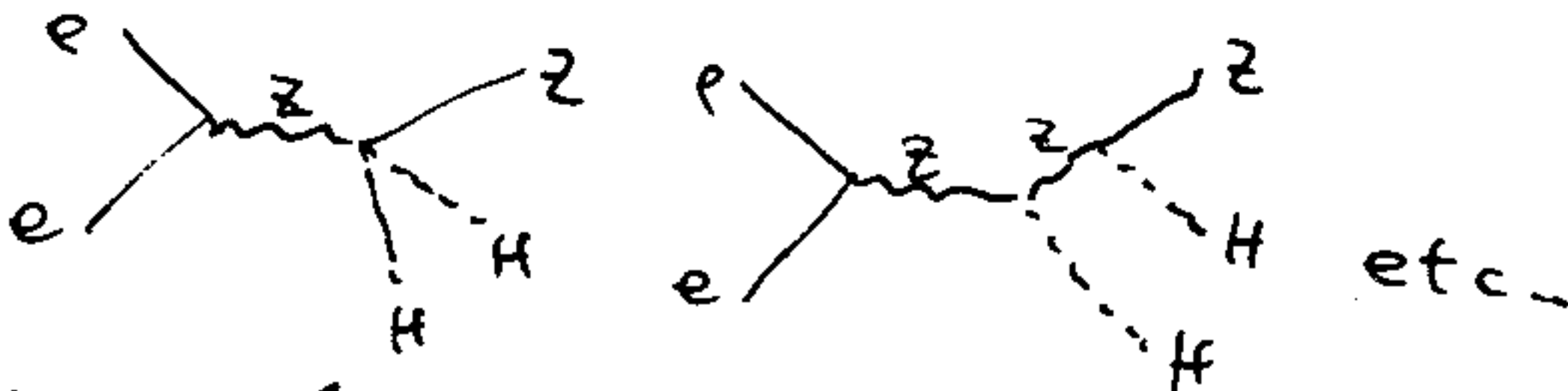
★ self-coupling = Very important



(direct scope to GUT)

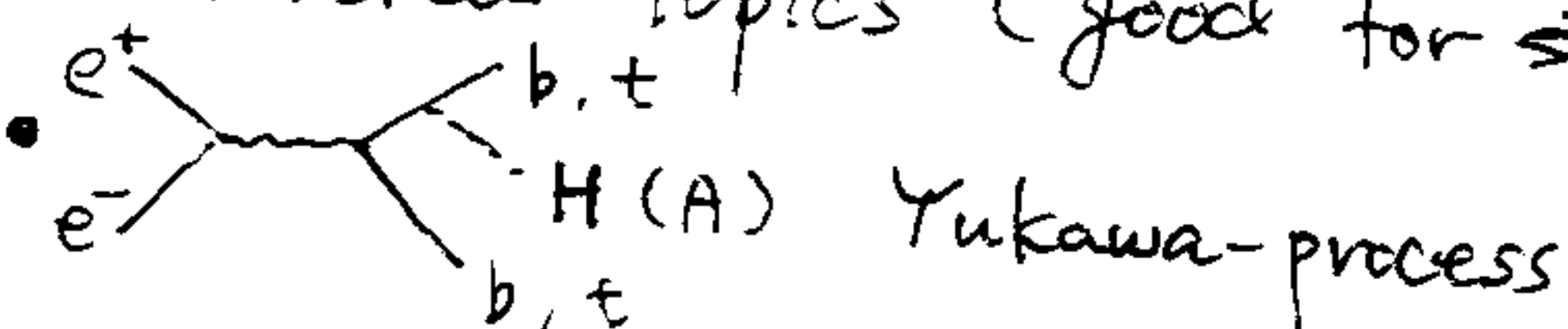
→ but very challenging

competing processes



★ CP ↔ $\gamma\gamma$ option is the best way
 (→ Watanabe-san's talk)

★ uncovered topics (good for students)



- invisible Higgs $h \rightarrow \tilde{\chi}_0^0 \tilde{\chi}_0^0$ etc.
- $e^+e^- \rightarrow Ah$
- $e^+e^- \rightarrow H^+H^-$

besides physics issues

A Lot of technical issues

= Towards ACFA report.

1. 3T magnetic field effect

2T → 3T studies to be done again.

2. τ -tagging upgrade

3. complete pol-beam option studies.

4. Need ← Now it's time to decide seriously.

MC data archive

- ★ JSF reference processes.
- ★ JIM selected processes

• Maybe KEK is the best place to store MC data.

• How to distribute data?

Media?
Tape, MC, network

direct access and open
CPU to ACFA?

And

Theoretical improvements
+ other WG inputs are needed for.

★ α_s determination + LQCD etc ...

→ better running b -mass, c -mass

↓

• b - τ coupling strength comparison

• down-up quark coupling "

• A mass, $\tan\beta$ etc determination.

★ S -fermion generators.

(some exist) ↓

self-coupling measurements

bkg estimates. Interference.

★ Theoretical translation of experimental sensitivities in more general SUSY, non-SUSY

NMSSM, 2HDM

Summary

1. Many BIG discoveries

expected in Higgs studies @ JLC phase I

definit answer to SUSY

physics between EW \leftrightarrow GUT

2. Initial studies for physics demonstration

\sim done. But many things still to do.

physics: Higgs-self coupling, τR

technical: full simulation, 2T \rightarrow 3T

pol-beam, τ -tag upgrade ...

organization: MC data storage.

3. LEP running in very good condition

Lepton Run 2 start next year soon.

\rightarrow highly expected to see signal indication

in γ 2000 - 2003.

We must prepare well for JLC in time.

Chance will come suddenly at any time.