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 Mh > 140 GeV ; MSSM dead
Mh > 210 GeV ; SUSY dead
Mh > 200 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 Br(h -> bb)/Br(h ->ττ).NOT.=.m_b^2/m_τ^2

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

5. From precise measurements
we can measure tanβ, α, A^0, H^0, H^+ mass etc..

S.YAMASHITA Satoru.Yamashita@cern.ch ACFA 3rd LCWS in Taipei 11-Aug-2000

Un official

LEP II running @ 208 GeV Now

Situation now = exciting !

☆ So far sensitive mass < 113 GeV

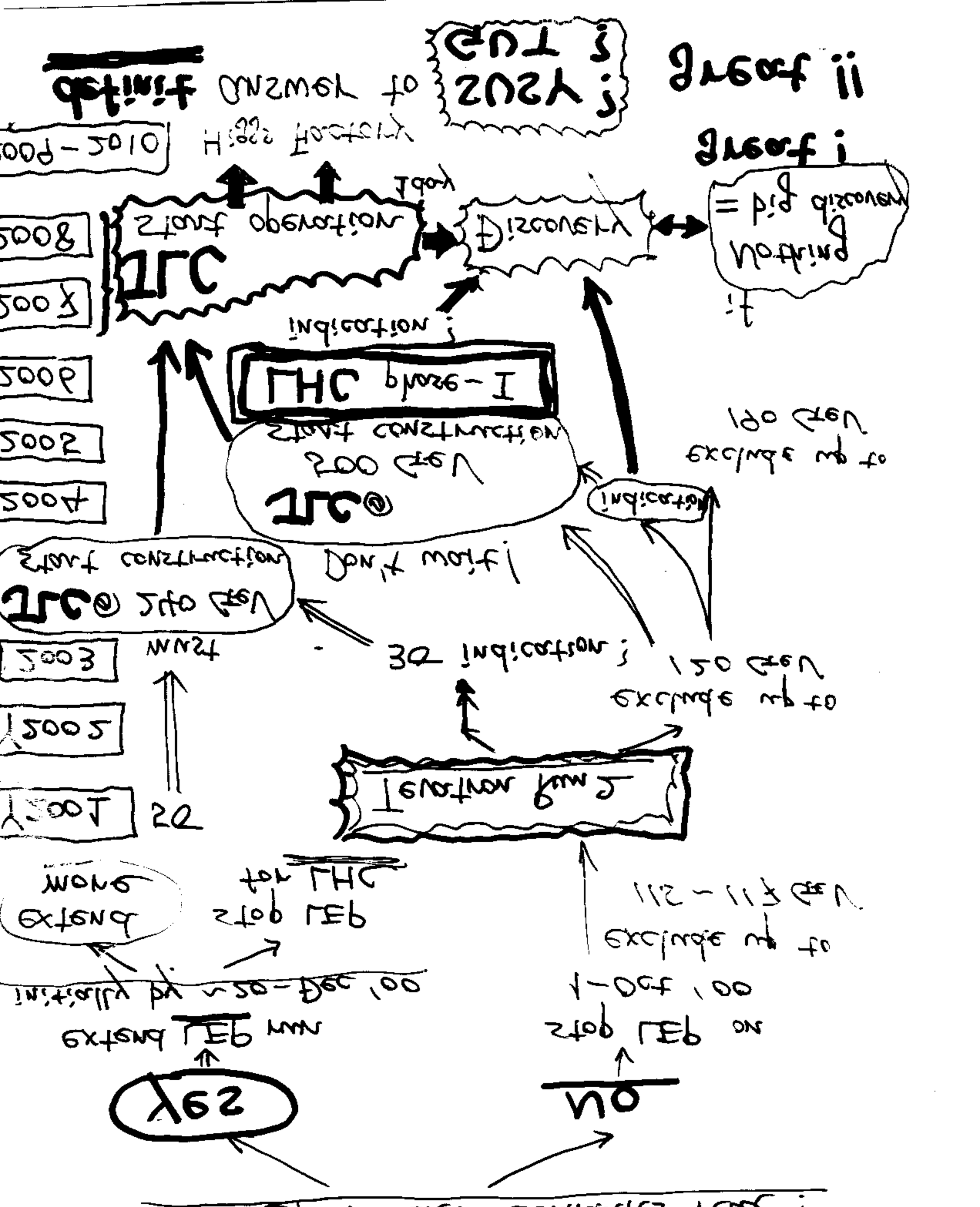
☆ "candidates" @ ~ 115 GeV !
A.D.L.O

by the end of September

→ 2.5-3σ ?

Important dates

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


Future branches
optimistic !
pessimistic ?
Q. LEP 115 GeV candidates "real"?
YES
extend LEP run
initially by ~20-Dec '00
stop LEP for LHC
extend more
NO
stop LEP on 1-Oct '00
exclude up to 115 ~ 117 GeV
Tevatron Run 2
exclude up to 120 GeV
3σ indication ?
5σ
must
Y2001
Y2002
2003
JLC @ 240 GeV start construction
Don't wait !
indication
JLC @ 500 GeV start construction
2004
2005
2006
exclude up to 190 GeV
LHC phase-I
indication ?
2007
2008
if Nothing = big discovery
Discovery
JLC start operation
1 day
great !
Higgs Factory
2009-2010
great !!
SUSY ? GUT ?
to answer
definit

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 <u>any time</u>.

1. Higgs gauge coupling, **total width**

$$\sigma_{hZ} \propto \left| \; Z \; h \; Z \; \right|^2 \propto \left| \; W \; h \; W \; \right|^2$$

$$\propto \Gamma_{h \dashrightarrow WW^*} \quad (= Br\,(h \dashrightarrow WW) \;\; x \;\; \Gamma_{tot})$$

$$\therefore \;\; \Gamma_{tot} = \eta \;/\; \eta^{SM} \;\; x \;\; \Gamma^{SM}_{tot}$$

$$\eta = \sigma_{hZ} \;/\; Br\,(h \dashrightarrow WW^*)$$

2. **Yukawa coupling Model independent**

$$\left| \; f \; h \; f \; \right|^2 \propto \Gamma_{h \dashrightarrow f\,f} = \Gamma_{tot} \;\; x \;\; Br\,(h \dashrightarrow ff)$$

$$\therefore \;\; \left| \; f \; h \; f \; \right|^2 = \xi \;/\; \xi_{SM} \;\; x \;\; \left| \; f \; h \; f \; \right|^2_{SM}$$

$$\xi = \frac{Br\,(h \dashrightarrow ff)}{Br\,(h \dashrightarrow WW^*)} \;\; \sigma_{hZ}$$

MSSM (type-II 2HDM) specific

β : **$\tan\beta = v2/v1$**

α : **Higgs mixing angle**

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

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

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

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

↑ ~ 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 $\ll 3\,fb^{-1}$ ← 1 day operation.

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

   → use JSF simulator → plots.

   → ☆ Yukawa-coupling absolute strength
   $\sim \delta = 5\%$ in ~2 years

   ☆ Γ_H total width $\delta = 5\%$ //

   ☆ HZZ (HWW) coupling $\delta \sim 3\%$ //

   ☆ Br measurements for (K. Ishii LCWS '99)

   $H \to WW$, bb, $\tau\tau$, cc, gg

   ↳ (I. Nakamura LCWS '99)

   ↳ Alister's talk.

3. Check possible problems

   → use JIM, JSF, simple simulation

   → ☆ beamstrahlung effects (I. Ueda LCWS '99)

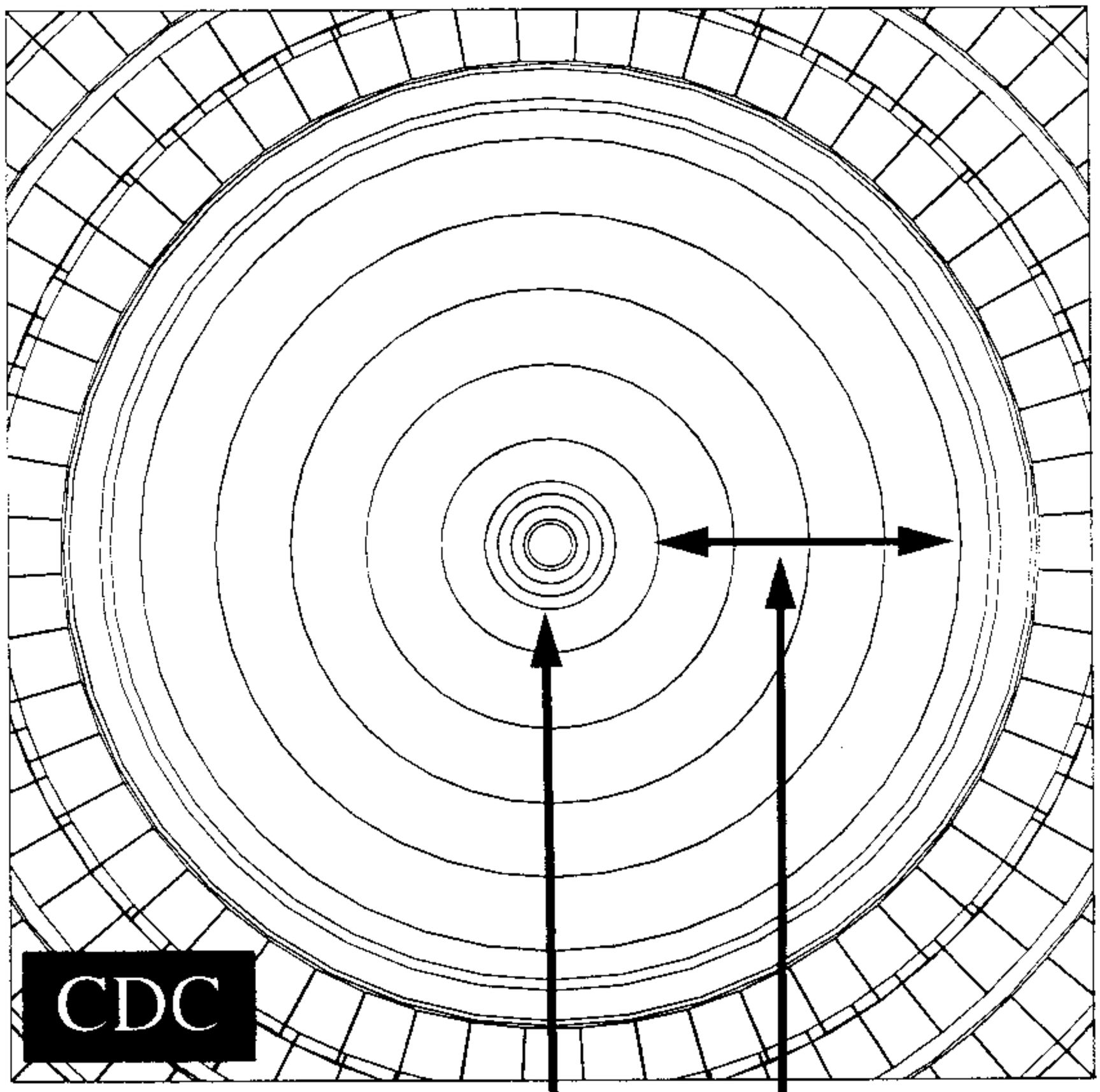
   ☆ two-photon overlap

   ☆ incoherent e^+e^- pairs (J. Kanzaki et al ACFA LC '99)

   → feed back to detector design.

   intermediate trackess (H.J. Kim et al)

   2T → 3T (Tauchi et al)



r = 450 - 2300 mm | z | < 2300 mm

$\sigma_{r\phi}$~ 100 μm σ_z ~ 1 - 3 mm

R&D results '98

$\sigma_{r\phi}$~ 85 μm with baby chamber

(JLC CDC subgroup)

5 Intermediate Tracker

(H. J. Kim et al)

r = 100-380 mm | cos θ | <0.9

$\sigma_{r\phi}$~ 20 μm σ_z ~ 20 μm

300 μm thick Si x 5 layers

(assumption)

4 layer SiVTX (CCD)

r=24 - 60 mm | cos θ | < 0.9 330 μm thick x 4 layers

σ ~ 5 μm

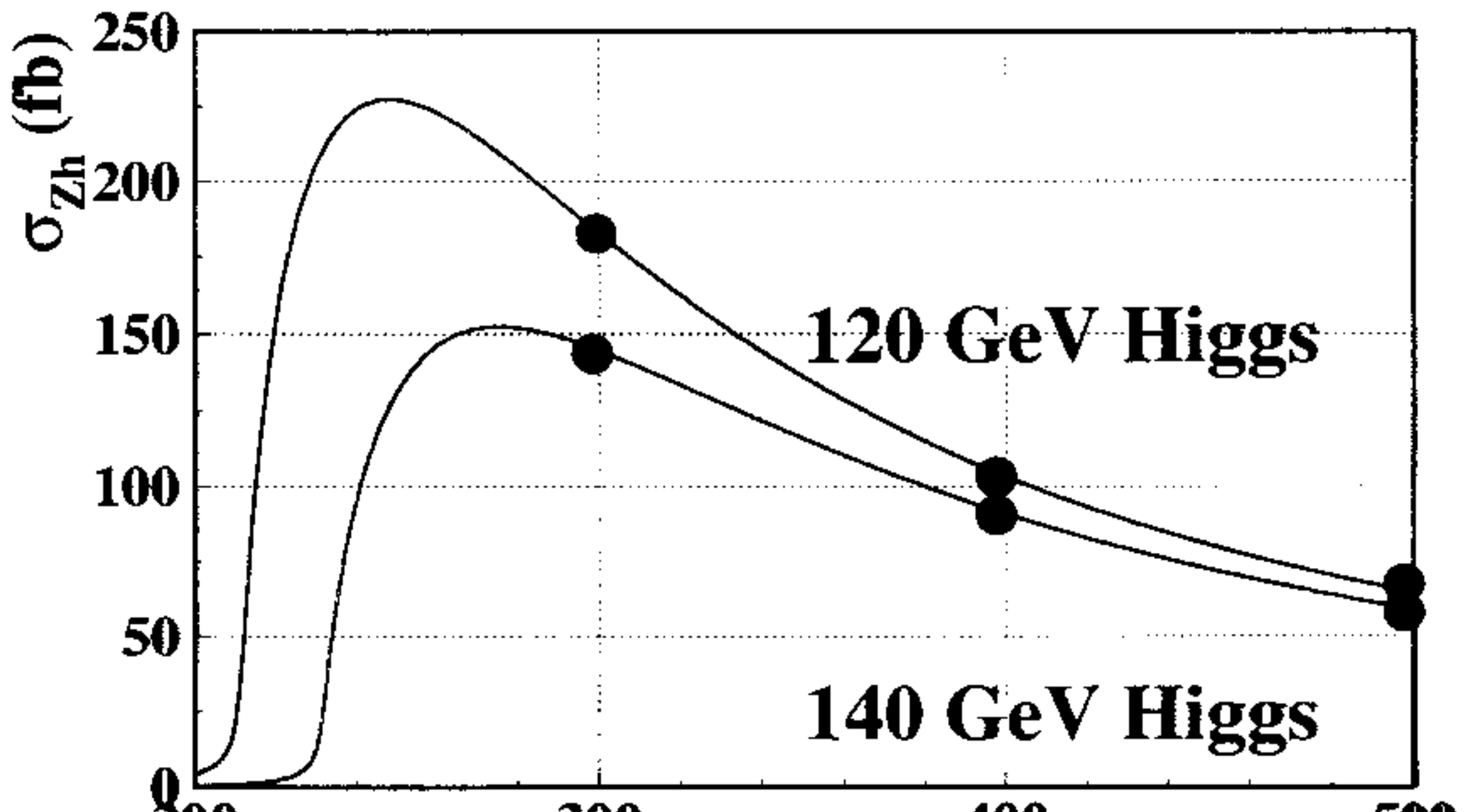
beam test results at KEK '98.

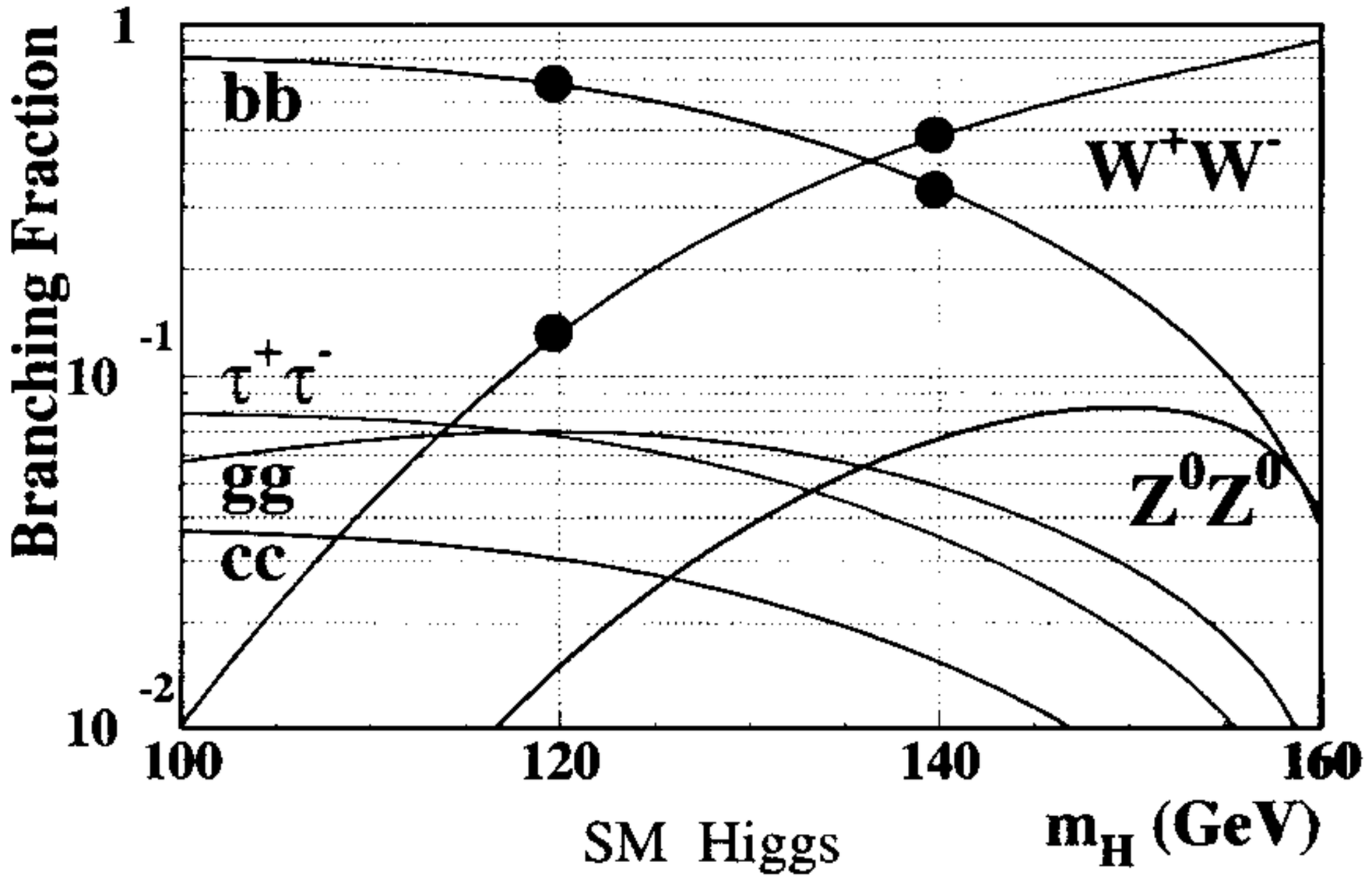
σ = 3 μm (JLC VTX subgroup)

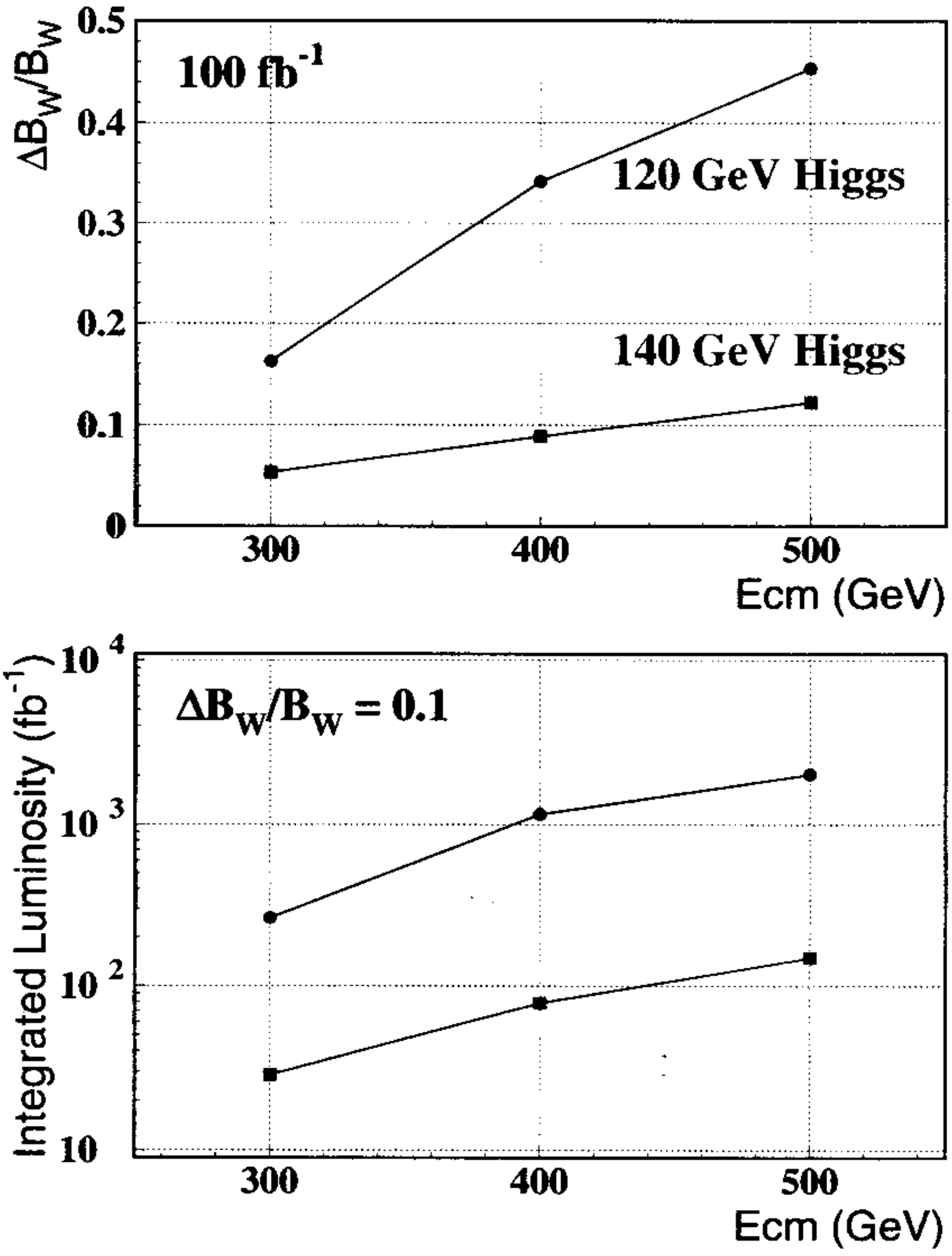
Sensitivity check

Higgs Mass = 120, 140 GeV
Ecm = 300, 400, 500 GeV

JSF (simdst) + beamstrahlung

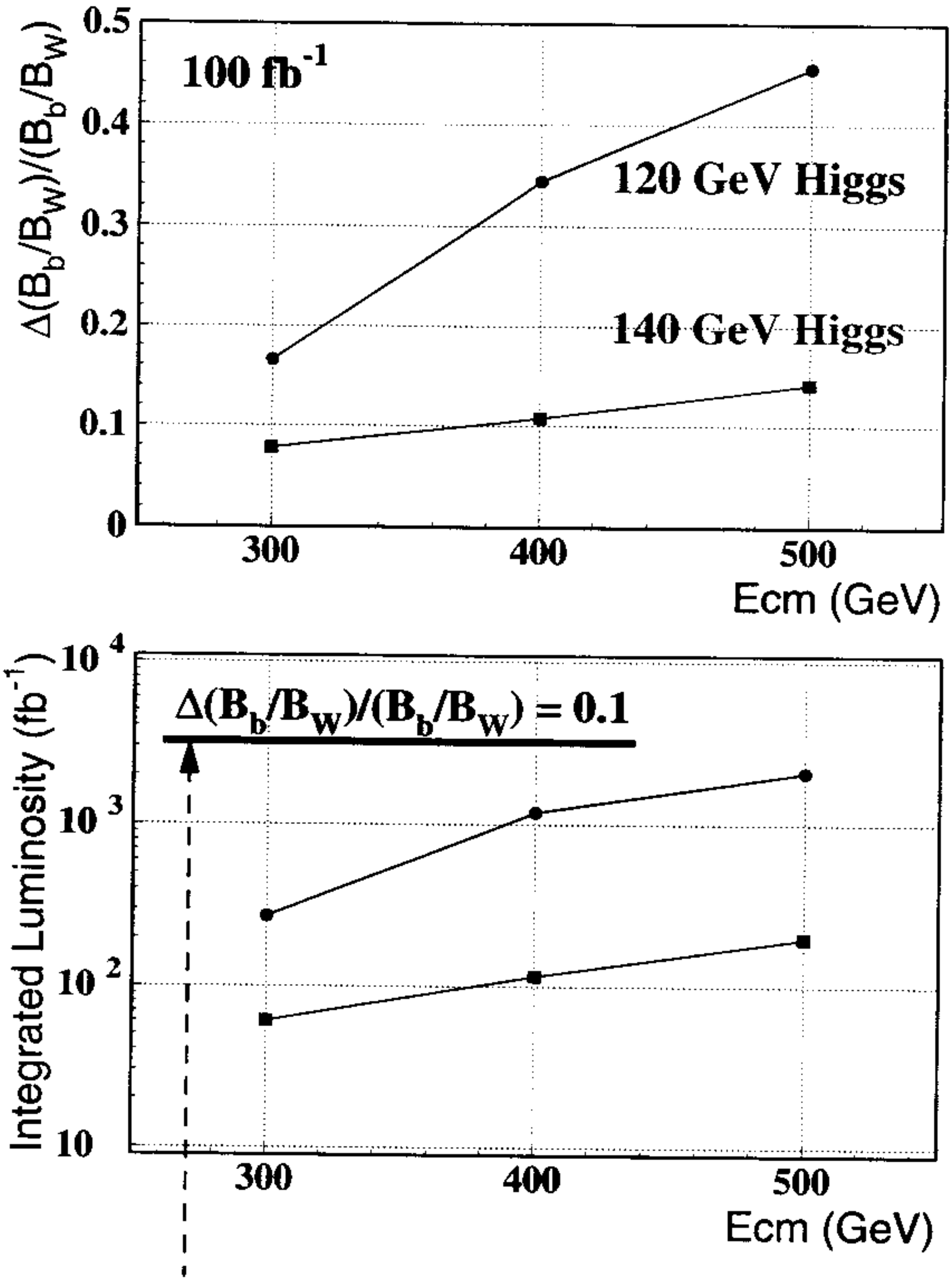






Total Higgs width measurement stat error ~ 5 %

Yukawa coupling



Yukawa coupling measurement stat error ~ 5 %

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

For main mode $e^+e^- \to HZ$ production

initial studies ~ demonstration phase

= almost Done

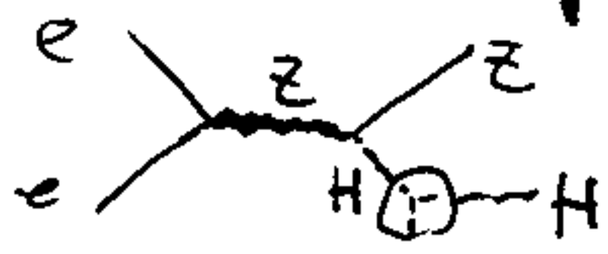
→ to be written.

What's NEXT

2 big physics + uncovered topics

World-wide + students + ...

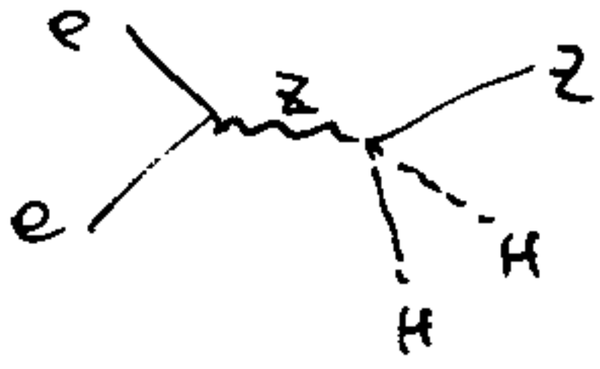
☆ self-coupling == very important

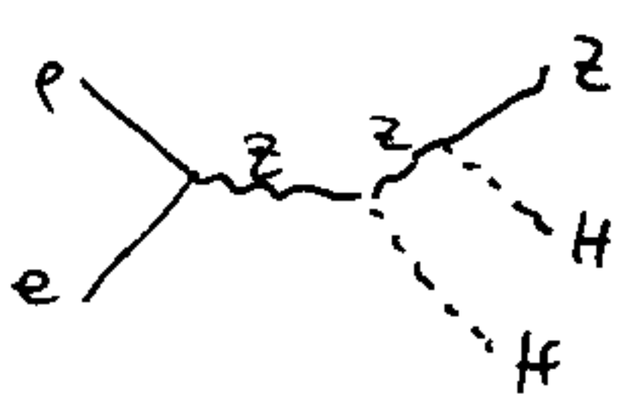


(direct scope to GUT)

→ but very challenging

competing processes



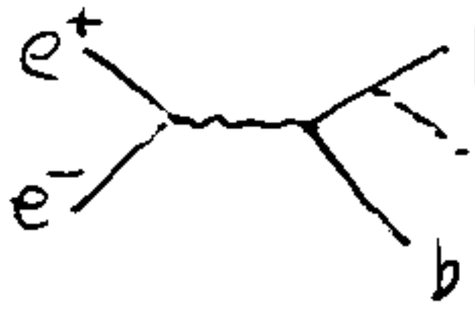


etc.

☆ $\not{CP}$ ⇐ $\gamma\gamma$ option is the best way

(→ Watanabe-san's talk)

☆ uncovered topics (good for students)



Yukawa-process

- invisible higgs $h \to \tilde{\chi}^0_1 \tilde{\chi}^0_1$ etc.
- $e^+e^- \to Ah$
- $e^+e^- \to H^+H^-$

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, MO, 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, tanβ etc determination.

☆ 6-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 ↔ GUT

2. Initial studies for physics demonstration
   ~ done. But many things still to do
   physics : Higgs - self coupling , ~~ER~~
   technical : full simulation , 2T → 3T
   pol-beam , τ - tag upgrade ...
   organization : MC data strage.

3. LEP running in very good condition
   Tevatron Run 2 start next year soon.
   → highly expected to see signal indication
   in Y 2000 - 2003.

We must prepare well for JLC in time.
Chance will come suddenly at any time.