

# The Higgs Working Group at the 2005 ILC Physics and Detector WS

*Sven Heinemeyer, CERN*

*on behalf of Shinya, Heather, Alexei and Tim*

*Snowmass, 08/2005*

1. Who are we?
2. Our charge and our interpretation of it
3. Our approach and activities
4. Conclusions

# 1. Who are we?

The convenors . . . so that you know our faces:

- Shinya Kanemura
- Heather Logan
- Alexei Raspereza
- Tim Tait
- Sven Heinemeyer

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But most important there is YOU!

We need your participation!

## 2. Our charge and our interpretation of it

### The charge:

- A) What are the **most important** measurements for Higgs physics?
- B) What are **new and important recent** developments?
- C) What will the **ILC add** to what will be known from the **LHC** ?
- D) What are the corresponding **detector requirements** to allow the corresponding **measurements** with the **appropriate precision** ?
- E) What are the corresponding **theory requirements** to allow the corresponding **measurements** with the **appropriate precision** ?

⇒ open lists

⇒ open for your participation and contributions!

## 2 A) Most important measurements

Much has been done in the last years:

TESLA TDR, Snowmass 2001 reports, ACFA report,  
ECFA WS documents, LHC/ILC report ...

... but needed for completeness, especially in view of

2 D) corresponding detector requirements

2 E) corresponding theory requirements

- Higgs spin,  $\mathcal{CP}$ , quantum numbers
- Higgs couplings to the gauge sector, up- and down-type quarks, charged leptons, self-couplings, loop-induced couplings  
→ Higgs width
- Higgs production in  $\gamma\gamma$  collisions (e.g. heavy MSSM Higgses)
- Precision electroweak measurements,  
indirect information about the Higgs

What is missing ???

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Why are these measurements important?  
What is the physics gain?  
What question are we after?

What is missing ???

## 2 B) Recent new and important developments

→ cover **holes** in existing analyses

→ being **prepared for everything** (as good as possible)

- Study of **heavy SM-like** Higgses
- **Rare decays** (e.g. to muons), **new decay modes** (e.g. to SUSY particles)
- “normal” extended models:  
NMSSM, general 2HDM,  $CPV$ , RPV, little Higgs, ...
- “exotic” extended models:  
Higgs and extra dimensions, Fat Higgs, composite Higgs, ...

What is missing ???

## 2 C) What will the ILC add to the LHC

- what does the ILC simply **add** or does better?
- what can be done in a **combined LHC  $\oplus$  ILC** analysis?

### What does the ILC simply add to the LHC?

- **model indep.** determination of **production cross section** and **total width**
- **model indep.** measurement of **couplings to SM gauge bosons and fermions**
- **trilinear** Higgs self-coupling measurement
- **Electroweak precision data** for indirect constraints
- production of **heavy MSSM Higgses**
- ...

What is missing ???

What is the **physics gain** ? (e.g. indirect distinction of models)

## What can be done in a combined LHC $\oplus$ ILC analysis

→ special Snowmass working group!

→ **LHC/ILC Study Group report**, hep-ph/0410364 as a good starting point

- **Combined** analysis of LHC and ILC data  
(→ coupling determination, indirect parameter determination)
- Can the ILC gives hints to the LHC **where to look?**
- ...

**What is missing ???**

⇒ awaiting collaboration with special working group

## 2 D) Corresponding detector requirements

⇒ mapping of “physics space” and “detector space”

⇒ not many analyses exist

difficult to do them here...?

⇒ but it is timely to answer this question!

- Higgs mass and self-coupling measurements:  
energy resolution important! (→ tracking, HCAL, ECAL resolutions)
- Higgs hadronic branching ratios:  
performance of vertex detector (→ 4 or 5 layers, granularity, . . .)
- Hermiticity?
- Momentum resolution?
- Impact parameter resolution?

What is missing ???

⇒ do not stick to few baseline designs in physics analyses!

(→ relying on full detector simulations and realistic event reconstruction)

## 2 E) Corresponding theory requirements

⇒ experimental precision can only fully be exploited if it is matched with theory calculation at the same level of accuracy

- Calculation of Higgs masses and mixings
- Calculation of Higgs branching ratios
- Calculation of Higgs production cross sections
- Calculation of electroweak precision observables
- Realistic theory error estimates
- Implementation of calculations in computer codes
- ...

What is missing ???

### 3. Our approach and activities

→ all information can be found on the Snowmass/Higgs web page

We started a document to

- coordinate our efforts
- collect known and new results
- list open issues and possibilities for contributions

→ all files are available at the web page

... under construction, awaiting your contributions

→ just take a look ...

We will have official “parallel sessions” to

- gather **new information** and contributions  
not “just talks”, but with the emphasis on the charge:  
What is most relevant? What is new? What does it add to the LHC?  
Detector issues? Theory issues?
- trigger discussions on the **open issues**

First meeting tomorrow in the “Kearns room”:

(1.30pm – 3.30pm, 5pm – 6pm)

topics:

- SM Higgs (experimental/detector aspects)
- MSSM (heavy) Higgs
- more exotic Higgses

We hope to have many independent/informal meetings

→ **come, join, contribute!**

## 4. Conclusions

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- Shinya Kanemura → 2HDM and ext., non-decoupling effects, ...
- Heather Logan → Higgs couplings, MSSM, little Higgs, ...
- Alexei Raspereza → experimental, machine and detector issues
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**Come to our meetings and contribute!**