

LHC Higgs Cross Section WG: Pseudo Observables

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Freiburg, 04/2010

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1. Introduction
2. What has been done (few)
3. What has to be done (a lot)

1. Introduction

“Pseudo observables” vs. “realistic observables”:

What is measured in a detector?

→ tracks and hits ... Ok:

- cross sections
- forward-backward (etc.) asymmetries
- line shape observables

⇒ realistic observables (RO)

What (else) do we want?

- particle masses
- partial widths
- couplings

⇒ pseudo observables (PO)

Extraction of PO from RO:

Depends on:

- experimental cuts
- detector effects
- experimental set-up
- ...

⇒ deconvolution (unfolding) procedure

- unfolding QED corrections
- subtraction of interference terms
- unfolding higher-order QCD corrections

⇒ model dependence enters

(POs are obtained in the SM!?)

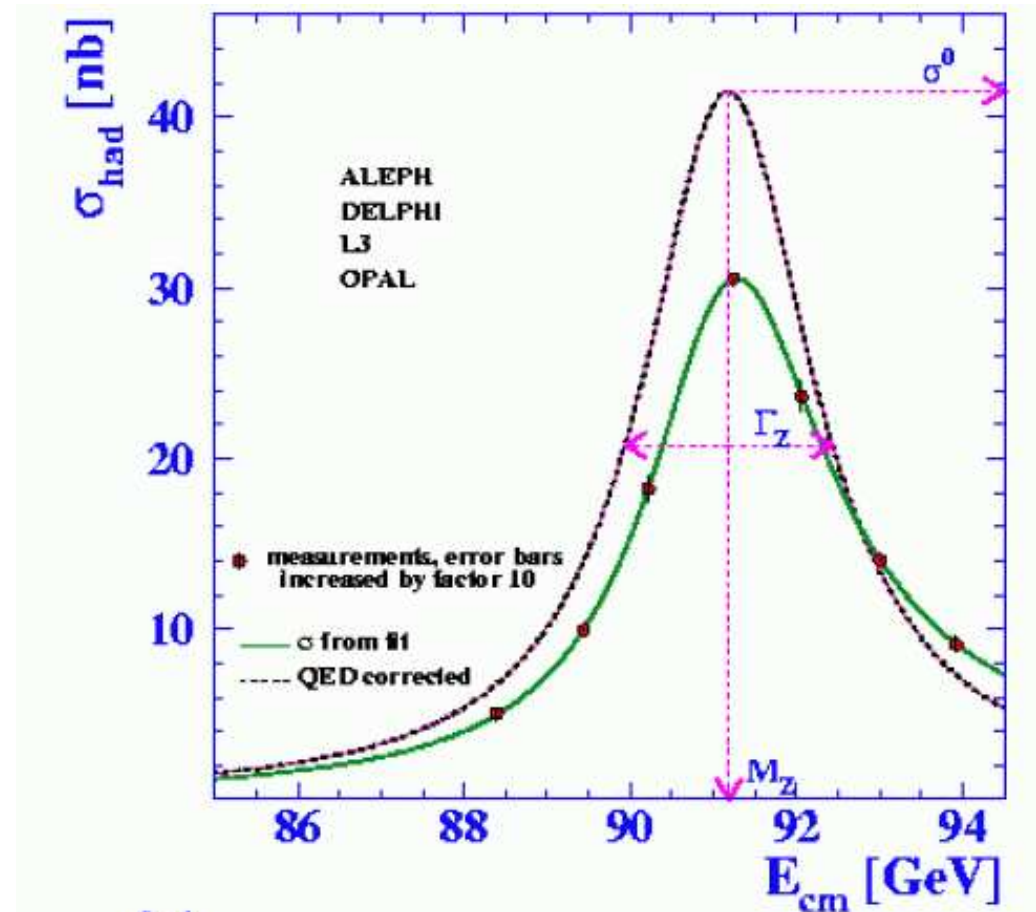
Example from LEP:

Realistic observables:

- $\sigma(e^+e^- \rightarrow Z \rightarrow f\bar{f})$
- Z line shape
- $A_b^{\text{FB}}, A_e^{\text{LR}}, \dots$

Pseudo observables:

- M_Z, Γ_Z, σ^0
 - $\sin^2 \theta_{\text{eff}}$
 - number of families/neutrinos
 - \dots
- M_Z depends (slightly) on M_H



RO → QED deconvolution → PO: $M_Z, \Gamma_Z, \sigma^0 = 12\pi \frac{\Gamma_e \Gamma_f}{M_Z^2 \Gamma_Z^2}$

A lot of important(?) work has to be done:

1. What are our pseudo observables?

mass? cross sections? partial widths? couplings? combinations?

Priorities?

2. How are/can they be extracted?

Model dependence?

3. Theory status?

Implications?

4. Status of MC tools?

– interference? background subtraction?

– extraction of $\Gamma \times \text{BR}$?

5. Necessary improvements?

6. ... ???

Problems: part I

The (few) people have quite different ideas what exactly has to be done, what are the priorities

“Theory side” :

- “Crystal clear” definitions
- What is the correct definition of mass?
- Raw data? Model dependence?
- Interference with background
- Impact of Higgs widths
- Impact of ISR, FSR, ...?
- ...

“Experimental side” :

- How to extract couplings?
- Can couplings be extracted?
- Interplay of XS and BR
- ...

Problems: part II

(Allowed) interaction between theory and experiment,
between ATLAS and CMS

(different “backgrounds” of theory and experiment . . .)

All “public” results need approval from ATLAS and/or CMS . . .

Now: **Solution seems to be found:**

Theorists (of LHC-Higgs-XS-WG) can work with (published) ATLAS/CMS data and perform “theory analyses” . :-)

2. What has been done (few)

First agreement:

Concerning the Higgs mass:

The object we have to deal with is the complex pole of the propagator.

The mass is the real part of the complex pole.

Implications?

Everything so far really done deals only with M_H . . .

First (simplified) overview of work:

1. Prepare an overview of “complexities” in order to clarify where which problem arises, i.e.
prepare a list of M_H regions with
 - relevant channels
 - relevant problems
 - irrelevant problems (i.e. possible simplifications)
2. Analyze mass definitions in MC tools:
 - which MCT are used for which M_H region/channel?
 - what is the respective M_H definition (if any)?
3. Compile a list of “best MCT”, i.e. the ones that include a proper M_H definition
4. Effects of MCT mass definitions on extraction of “correct” mass?
 - Comparison?
 - Conversion?

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Related idea: first step(s) in $\gamma\gamma$

- take $\gamma\gamma$ distributions (realistic, but fake) including errors
needed: RO, not “only” raw data
important: how are PO extracted from RO?
- perform “mass extraction” with “box detector”
(neglect for now experimental issues, “don’t touch detectors”)
→ $M_H, \sigma(gg \rightarrow H) \times \text{BR}(H \rightarrow \gamma\gamma)$ extracted from complex pole
→ how/which MC tool?
- compare with real mass (definition)
- analyze effects of mass extraction, MCT, interference, etc.

So far: “TH proposal”, under discussion between TH and EXP ...

If this works out, next step could be $H \rightarrow ZZ \rightarrow 4l$

3. What has to be done (a lot)

1. Prepare an overview of “complexities” in order to clarify where which problem arises, i.e.
prepare a list of M_H regions with → continue
 - relevant channels
 - relevant problems
 - irrelevant problems (i.e. possible simplifications)
2. Analyze mass definitions in MC tools: → check MCT
 - which MCT are used for which M_H region/channel?
 - what is the respective M_H definition (if any)?
3. Compile a list of “best MCT”, i.e. the ones that include a proper M_H definition
4. Effects of MCT mass definitions on extraction of “correct” mass?
 - Comparison? → perform comparison
 - Conversion? → determine conversion

More things to be done:

- Extend list of POs
 - more “crystal clear” definitions
- What can be extracted? How?
 - $\Gamma \times \text{BR}$? spin? quantum numbers?
- Prepare for more complicated scenarios?
- ...

Do we need a new MCT for PO extraction?

Problems: part III

Q: What is urgent? How to continue? Focus on 1 fb^{-1} @ 7 TeV?

PO contacts:

Michael Dührssen, Martin Grünewald, S.H., Giampiero Passarino

+ some more “expressed interest”

⇒ more experimentalists needed!

⇒ more theorists needed!

Q: How to exploit overlap with other groups?