

Theory Uncertainties in Higgs Searches



All

(compiled by Giampiero)

Introduction to Section IX and X

BNL Workshop, 4–6 May 2011



Ceterum censeo

Corrections can (and will!) change in the transition from the total to integrated XS based on selection cuts

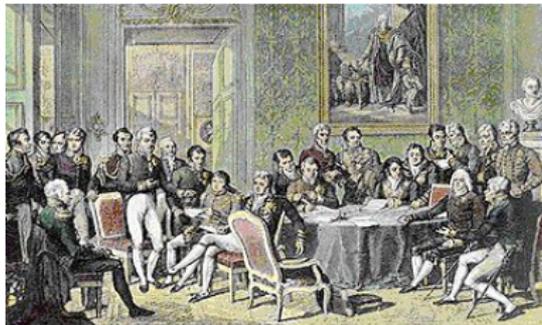
Disclaimer:

All for the sake of the Summer Conferences, with the understanding that these are a short-term fixes rather than long-term agreements, written in stone ...



we want to work out a reasonable procedure
come up with quick recommendation

} **compromise**



Options

- 1 We do some *deep* investigation to discover that the Bayesian approach is frustratingly difficult to apply because of the assessment of the likelihood function (see work of Glen Cowan) but not for the Summer
- 2 is it worth wasting time? ggF @ 140 GeV

method	68%(90%)CL	
quadratically	22.3%(22.7%)	} 2.7%(4.4%) ??????
envelope	24.9%(26.9%)	
linearly	25.0%(27.1%)	



Procedure

- 1 Calculate Γ s and corresponding BRs for each parameter variation \leadsto individual PUs
- 2 Combine individual PUs for BRs (and Γ s) in quadrature \leadsto overall PU
- 3 Calculate errors for Γ s and corresponding BRs for each total TU \leadsto individual TUs
- 4 Combine the individual TUs linearly \leadsto overall TU
- 5 Combine the overall TU and the overall PU linearly \leadsto final uncertainties



Questions in Ask Box

Prescription needed

- central value of $\sigma A =$ any NLO–MC re-weighted with H_qT ?
- Uncertainty from scale, how to select and vary the scale?
- Vary the PDF (MSTW2008NNLO) and take the 90% CL?
- Add difference MC@NLO – POWHEG? Negligible after re-weighting?
- Something more?
- Something less?



$$\sigma_{\text{vis}} = \sigma_T Af$$

how to handle THUs in the combination:

- 1 take the inclusive XSs and their THUs from the CERN Yellow Report
- 2 estimate acceptance (except that on jet bin) uncertainties from scale, PDF, α_s etc. using appropriate MC programs and assume they are independent of those on the total inclusive XSs
- 3 estimate jet bin uncertainties separately and implement them as
 - f_0 fully anticorrelated with the total XS ($c = -0.99$)
 - f_1 fully correlated with the total XS ($c = 0.96$);
 - f_2 fully correlated with the total XS ($c = 0.95$)
- 4 Take differences between different NLO MC generators as an independent systematic source



QCD scale unc. in $H + 0, 1, 2$ -jets:

- 1 The scale dependence is considerably larger for $H + 1, H + 2$ jets compared to $H + 0$ jets or the full inclusive, mostly because they are computed to one order lower in QCD.
- 2 For $H + n$ jets, when a jet veto is imposed there is an extra scale in the game, the p_T of the jet.
- 3 In the case of $H + 1$ jet don't use $M_H(M_H/2)$ but some combination like $(M_H + p_T)/2$.



High-Mass

Breit-Wigner:

- 1 How one can approximate Breit-Wigner lineshape to the exact calculation.
- 2 Heavy Higgs is ill-defined theoretically, and we have to wait the recommendation from theorists for each NLO MC.
- 3 Spectrum of Higgs p_T for heavy Higgs (are MCs correct in this region?)
- 4 Crude estimate of Higgs line-shape uncertainty including the interference effect with SM backgrounds.
- 5 Scale choice: there is no physical reason to take a very high scale, while outgoing four lepton scale is much lower (low Higgs p_T ?)



PDF:

- 1 New recipe for NNLO?
- 2 What to do for estimating PDFU in differential XS?
- 3 New/pragmatic PDF4LHC recipe, update of PDF, PDF + α_S error correlations?



Summary:

(2, 3, 4)

- ① *Uncertainty in differential XS including acceptance*
- ② *Common issues: QCD scale, PDF + α_s , NLO MC modeling, acceptance correction with Higgs XS, extrapolation from control to signal region*
- ③ *Common cuts: effect of jet-veto, Higgs p_T , etc.*
- ④ *Prepare a common guideline for ATLAS and CMS on these issues*



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