Discussion Session: toward cross section with cuts and more

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Discussion Session

2h for exclusive Higgs XS calculations

- Common cuts: with **pre-selection** cuts or **quasi-final** cuts?
- Which feedback can be achieved when using **NLO/LO MC**?
- MC reweighting via Higgs $\mathbf{p_T}$, η, etc? Develop common tools?
- How should we define **TH errors** in exclusive Higgs XS?
- Common recipe for extrapolation from control to signal regions (e.g. **QCD scale, PDF error**)?
- Parton level vs PS-MC study?

- Common cuts: with **pre-selection** cuts or **quasi-final** cuts?

- Depends if the K factor depends on the variable on which you cut.
- Carefully check all the cut
- Minimize the number of “common cuts” after

which one will compute the “acceptance” and thus the cross section.

Cross Section(with cuts) = inclusive cross section * acceptance

- Which feedback can be achieved when using **NLO/LO MC**?

- Make a list of differential distributions to compare between NNLO programs w.r.t. to NLO MC. Th+Exp join in running job and preparing these plots.

- MC reweighting via Higgs $\mathbf{p_T}$, η, etc? Develop common tools?

- NLO Monte Carlo
  - Differential distributions may have non-constant K-factor
  - Develop reweighting scheme for NLO(LO) MC based on NNLO?
- Higgs pT correct distribution?

- How should we define **TH errors** in exclusive Higgs XS?

- Take MH=120, 200 GeV
- QCD, PDF+alpha_s error ?

- Common recipe for extrapolation from control to signal regions (e.g. **QCD scale, PDF error**)?

- Depends very much on the process and on the experimental error

→ example on blackboard

2h for exclusive Higgs XS calculations

- For which Higgs decay channel should we use **PS-MC**?
- How to define **jets, b-jet/τ, isolation, jet-veto** etc?
- How to use these results in exps whith different exp details?
- Prepare tools? Parametrisation? Which distributions are most relevant for which channel(reweightings)?
- How to include signal and background interference effects? With **LO MC**? Then, how to extrapolate to higher order? (e.g.. $\mathbf{qq/gg} \to \gamma\gamma, \mathbf{qq/gg} \to \mathbf{WW/ZZ} \to \mathbf{l}\nu\mathbf{l}\nu$ etc.
- How to organize future work and milestones with a careful planning of the interaction **production** groups $\otimes$ **decay** groups?

How to define cuts at parton level?

- Jets pt, DeltaR -- parton direction

  jets in experiments are usually defined as DeltaR = 0.3-0.5 (forward --0.5-0.7)
- Jet veto
- Missing ET
- Isolation

Proposal on how to compare σ_{exp} (ϕ/Z+b) with σ_{th} (ϕ/Z+b)

- **Cuts used in analysis:**
  - Exp. cut: $p_T^b > p_{T\,exp}^{cut}$
  - Gen cut at LO ME+PS : $p_T^b > p_{T\,gen}^{cut}$
  - Th. cut for σ_{th} at NLO : $p_T^b > p_{T\,th}^{cut}$
- **The way could be:**
  - use Gen cut = Th.cuts ($p_{T\,gen}^{cut} = p_{T\,th}^{cut}$)
  - use Exp.cut > Th. Cuts
    - $p_{T\,exp}^{cut} > p_{T\,th}^{cut} + \sim 2 \times \sigma_{\text{jet resolution}}$
  - go from p_{Texp} to p_{Tth} cuts using MC; correct difference in acceptance (p_T, η) between NLO and ME+PS using factor:
    - $R = [\sigma_{th}^{exp.cuts}/\sigma_{th}^{th.cuts}] / [\sigma_{LO+PS}^{exp.cuts}/\sigma_{LO+PS}^{th.cuts}]$,
      - for LO ME+PS apply p_T/η cuts on parton b-jets

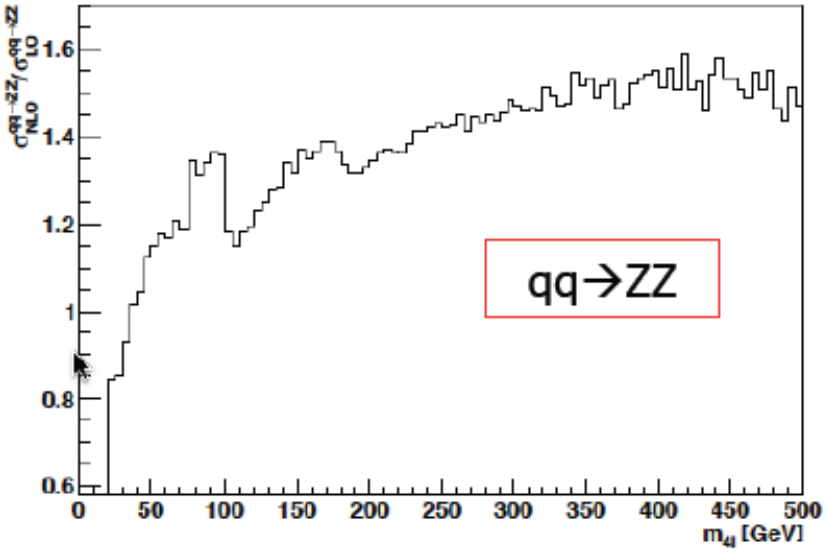
H->ZZ

- Differential K factor:
  - Signal : "Grazzini" vs powheg
    Partially already done at NLO by Grazzini/Nason/Maltoni
    Complete the study:
    a) NNLO vs NLO as a function of the variables on which we cut.
    b) NLO Grazzini vs Powheg/MC@NLO
    c) Powheg vs mc@nlo differences

  - Background :
    Zbb studies done by Reina → hopefully soon in Powheg
    - good definition of control region – we should define the TH precision that we need on Zbb in the control region

H->ZZ (2)

ZZ(*) : Madgraph + k factor (that has a M(4l) dep.)
(generation qq->l+l-l+l-)

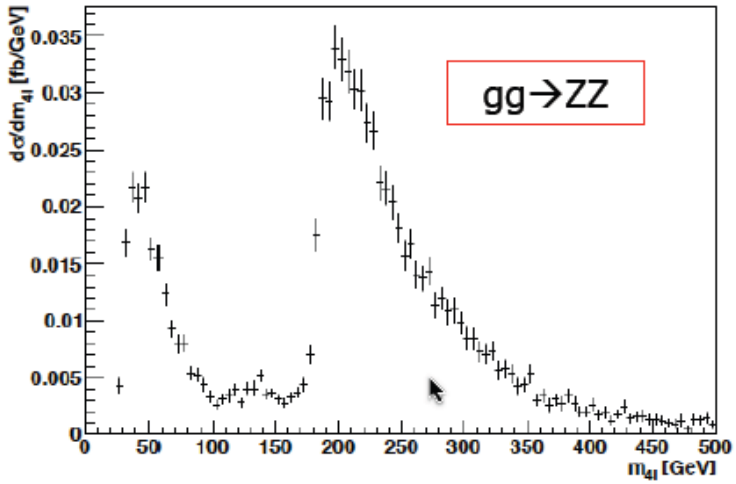


M(Z(*)) down to 20 GeV.

H->ZZ(3)

ZZ(*) rate controlled with single Z rate?

- ZZ control region :
  ZZ / Z ratio: which precision do we need?
- Try to control it with Zgamma
- gg->ZZ



H->WW

- Common cuts defined
- Differential K factor under study (different group) - agree well on the jet-veto definition at parton level and define a TH and EXP error

BACKGROUND:

- qq->WW only at LO?

  - **Tools to reweight MC events for acceptance calculations**
  - **Tools to provide K-factors**
  - **Tools to obtain differential cross-sections**
  - **Tools to get theoretical uncertainties**

H->WW(2)

- Comparing cross section between HNNLO/ Pythia or HNNLO/MC@nlo has no sense !

- HNNLO (NNLO/NLO) comparison should be done for cross sections and differential distributions
- Comparison of differential distribution between HNNLO vs NLO-MC

H->tautau

- No cuts on Higgs decay possible
  (ok for the XS calculator)

- gg->H implementation of full massive top/bottom loops esp. for SUSY in LO event generator or PWHEG and not only effective ggH vertex
- „gg->bbH" implementation in POWHEG
- implementation of Higgs decays in cross section calculators
- differential NNLO calculation in 5flavor scheme for bb→H

H to tautau

- bbH gb->bh ?????

  I have not understood anything

H->gammagamma

1.- A robust procedure for the estimation of systematic errors on differential cross-section predictions (in particular on qT)

2.- A procedure for the estimation of error on fragmentation

3.- Is an NLO version of SHERPA on the horizon? Can we use SHERPA as it is with a simple k-factor?

4.- Definition of parton-level pseudo-isolation cuts and the best scales to use

* Joey wish …?

H->bb

- Differential XS

- Wish List for Theorists
  - $VH \to Vb\bar{b}$: fully differential parton-level predictions @ NLO (QCD + EW), Zbbbar and Wbbbar backgrounds @ NLO implemented in a parton shower program, fully differential parton-level predictions @ NNLO (QCD)
  - $t\bar{t}H \to t\bar{t}b\bar{b}$: NLO signal and background MC, LO-NLO shape comparison for signal and background

H+->taunu

- Full implementation of t → bH+ in MC@NLO and/or Powheg, keeping spin correlations
  - Highest priority is H+ in ttbar decays (i.e. light H+)
- Theoretical uncertainty on BR(t->bH+)

Other items:

VBF

- Add a group with VBF decays:

  cuts on the tag jets + the decay of the Higgs

--------MORE GENERAL ----------

Think on a possible new structure of the group

Or simply organized structured meeting…

Give us idea and feedback.

2. Higgs decays: theory uncertainties

However: there are theoretical uncertainties....

- **Input quark masses in** $\mathrm{H} \to \mathrm{b\bar{b}}, \mathrm{c\bar{c}}$

$$\mathrm{M_Q^{pole}} \to \overline{\mathrm{m}}_\mathrm{Q}(\mu = \mathrm{M_H})$$

– $\overline{\mathrm{m}}_\mathrm{b}(\mathrm{M_b}) = 4.19^{+.0.036}_{-0.012}$ **GeV**

– $\overline{\mathrm{m}}_\mathrm{c}(\mathrm{M_c}) = 1.27^{+.0.014}_{-0.018}$ **GeV**

- **Theory+experimental error on** α_s **:**

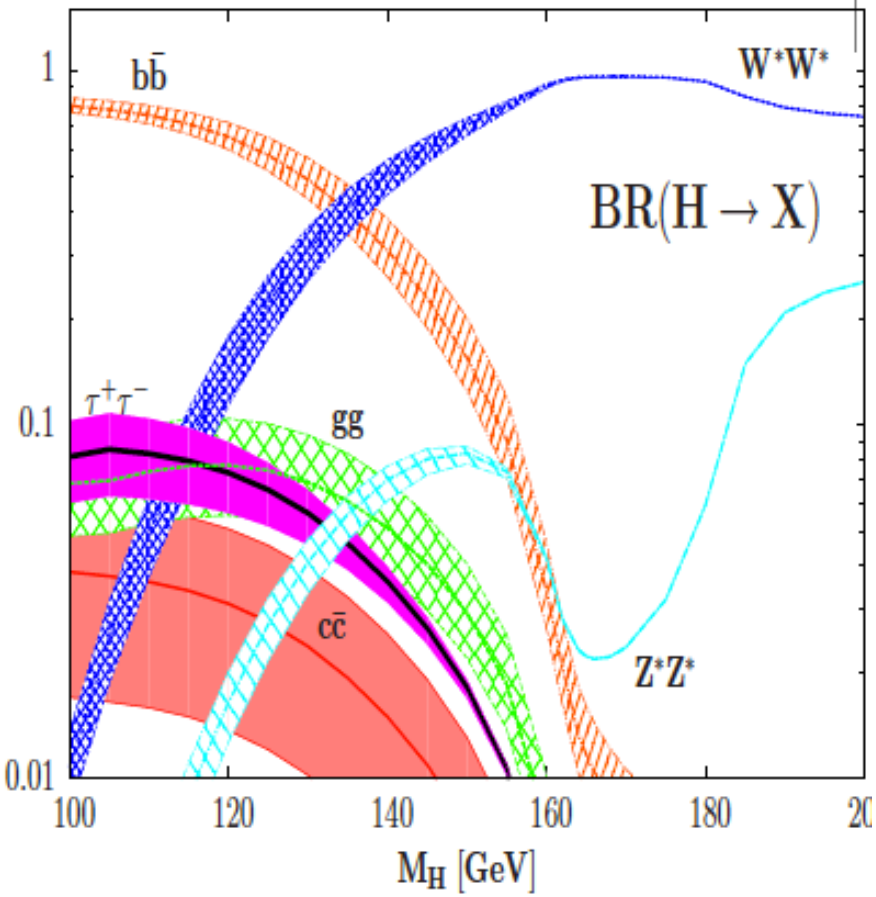
$$\alpha_\mathrm{s}(\mathrm{M_Z^2}) = 0.1171 \pm 0.0028 \text{ @NNLO}$$

- **Scale error: measure of higher orders**

$$\tfrac{1}{2}\mathrm{M_H} \le \mu \le 2\mathrm{M_H}$$

- **Scale and** α_s **errors in** $\mathrm{H} \to \mathrm{gg}$

$$\Gamma(\mathrm{H} \to \mathrm{gg}) \propto \alpha_\mathrm{s}^2 + \text{large } \mathcal{O}(\alpha_\mathrm{s}^3)$$



Baglio,AD

Include all items ⇒ large uncertainties!

esp. for $\mathrm{M_h} \approx$**120–150 GeV: 10–30% for** $\mathrm{H} \to \mathrm{b\bar{b}}$ **and** $\mathrm{H} \to \mathrm{WW}^*$

The TH error on the “exclusion plot”

- Assuming the Th error negligible w.r.t. to the experimental error, we move the TH error to the “SM prediction==line at 1”