

Template cross sections

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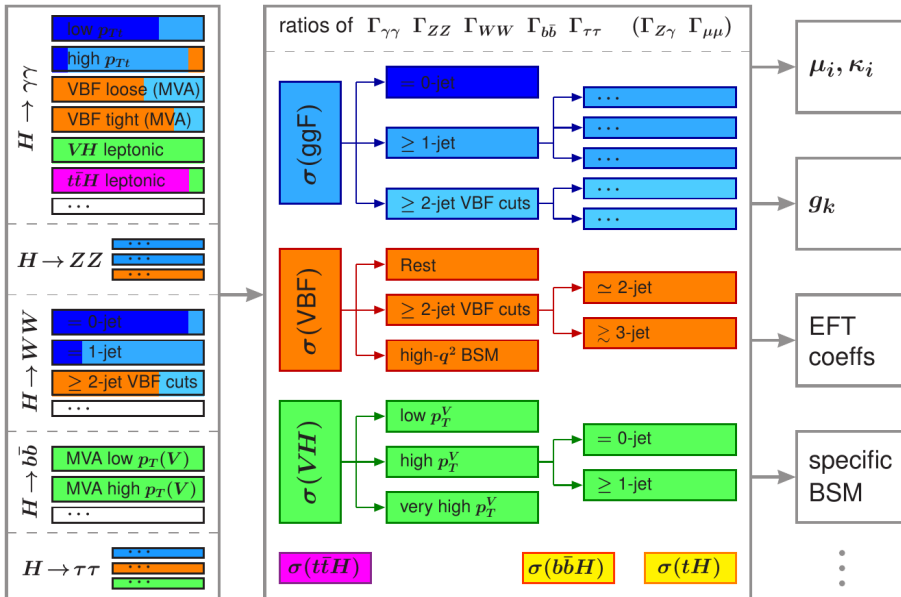
Overview

- Template cross sections (also known as simplified cross sections):
General framework based on exclusive categories for Higgs boson measurements
- First introduced by Kerstin Tackmann/Frank Tackmann, supported by Higgs conveners
- Original Plan:
Combination of measurements in various decay channels for Moriond
→ Moved to ICHEP, at the moment planned with all channels
($H\gamma\gamma$, $H4\ell$, HWW , $H\tau\tau$, $Hb\bar{b}$, $t\bar{t}H$, $H\mu\mu$)

Sources:

- LHC Higgs cross section working group meeting (14th January 2016, Kerstin Tackmann)
<https://indico.cern.ch/event/407347/session/4/contribution/25/attachments/1211675/1767532/SimplifiedTemplateXS.pdf>
- $H4\ell$ (22nd January 2016, Fabio Cerutti, HZZ Weekly):
https://indico.cern.ch/event/486609/contribution/3/attachments/1215958/1775712/Categories_20January2-015.pdf
- $H\gamma\gamma$ (20th January 2016, Dag Gillberg and Thibault Guillemin, HComb Weekly):
https://indico.cern.ch/event/482745/contribution/0/attachments/1214690/1773242/Higgs_Truth_HComb_200116_Guillemin.pdf
- Overall status (20th January 2016, Elisabetta Pianori, HComb Weekly):
https://indico.cern.ch/event/482745/contribution/1/attachments/1214554/1773001/SimplifiedXSFeedbackRequest_20_01_16.pdf

Simplified template cross section framework.



High Lumi $H4\ell$

Version 1 optimized for VBF/VH and very high luminosity

M4l [115-130] GeV - 5 Bins in M4l to increase sensitivity

keep lepton flavor subdivision

$P_{tj} > 30$ GeV

≥ 1 leptons

0-jet

1-jet

2 or more jets

$P_{th} < 125$ GeV
125-200
>200

$P_{th} < 125$ GeV
125-200
>200

$P_{th} < 125$ GeV
125-200
>200

$40 < M_{jj} < 130$ GeV

$M_{jj} > 130$ GeV

$P_{th} < 125$ GeV
125-200
>200

$P_{th} < 125$ GeV
125-200
>200

Use m4l as discriminant or none ?

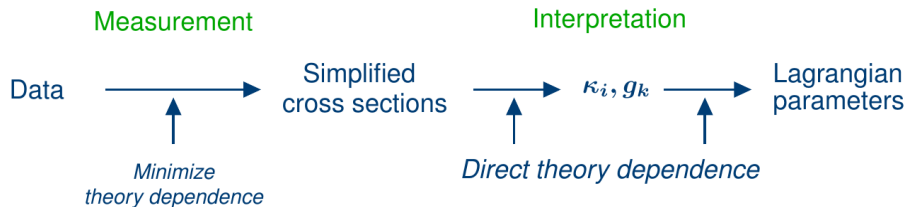
Discriminant BDTzz ? or $KD = ME-SM / MS-BSM$

Discriminant BDT-1j ?

Discriminant M_{jj} , $ME(VH)$ or BDT ?

Discriminant $ME(VBF)$ or BDT, KD ... ?

Goals & Advantages



Goals & Advantages:

- Minimize theory dependence in measurements
 - Decoupling measurement from specific models → Results long-term useful
- ⇒ Measurement of SM production modes; Input to global interpretations (κ fits, **BSM EFT measurements**); Complementary to differential cross-section Measurements

Goals & Advantages

Categorisation based on

- 1 Number of additional leptons (VH category)
 - 2 Number of jets: 0-jet, 1-jet, \geq 2-jet
 - 3 Within category using bins of $p_{T,H}$, p_{T,j^1} and/or m_{jj}
- Categorisation similar/compatible between decay channels \rightarrow Combination
 - Flexible approach, merge pth or categories for low luminosities or for measurements where they do not improve sensitivity
 - Has to be adapted to available statistics per decay channel

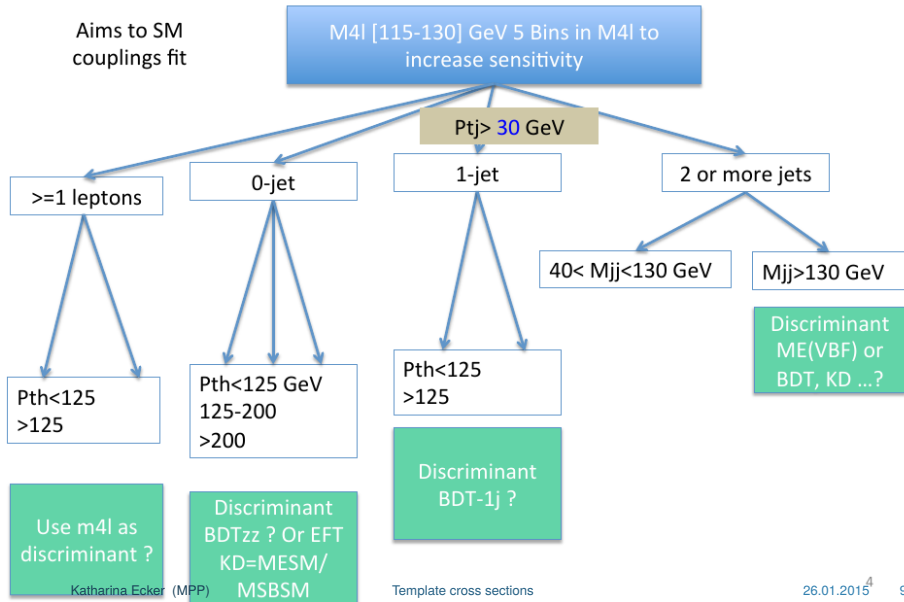
General Design Layout

- Identify phase-space regions that are most important to separate out from the theory side
 - According to largest theory uncertainties (example ggF jet bins, large uncertainty for 2-jet)
 - Depending on BSM sensitivity (for example high $p_{T,H}$ bins)
- Minimize residual theory dependence (Split in production modes eliminates uncertainty from production mode dependence)
- Bin definitions can evolve with statistics: For example scheme $H4\ell$ high and low lumi

Efforts per decay channels

- $H\gamma\gamma$: Truth classifier presented in 20th January HComb (see link slide 2)
- HWW : Effort has not started yet
- $H\tau\tau$, $Hb\bar{b}$, $t\bar{t}H$, $H\mu\mu$: Not aware of any started effort
- $H4\ell$: First presentation 22nd January, more details in the following

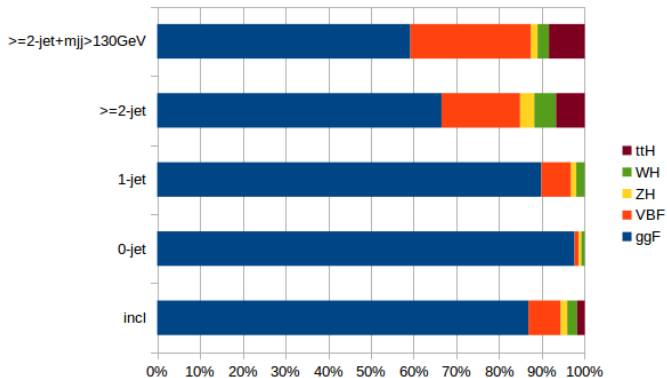
Categories can be merged at lower luminosity: 20 fb^{-1} or for specific coupling measurements



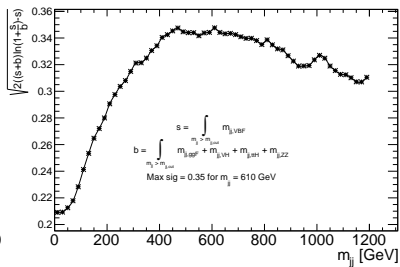
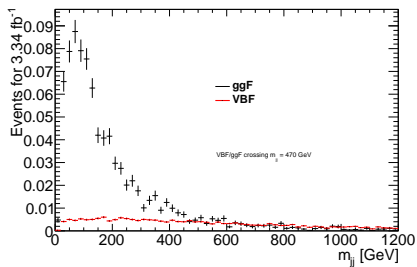
Expected Yields per decay channel for $\mathcal{L} = 10 \text{ fb}^{-1}$

****Events weight all:****

	4mu	4e	2mu2e	2e2mu	all
1 - all	5.5532120494	3.1357608068	3.3040145756	3.6708580523	15.6645036604
2 - masscut	5.29718151	2.9022997275	3.1158061013	3.4280807881	14.7437749995
3 - 0-jet	2.1331071601	1.1671558112	1.2290512989	1.4434581774	5.9727395387
4 - 1-jet	1.7164158118	0.9851132512	1.0498209462	1.1236413897	4.8746922278
5 - ≥ 2 -jet	1.447969676	0.7499857894	0.8369308646	0.8612145744	3.8958944764



M_{jj} cut in 2-jet category



Summary

- Template or Simplified cross-section define a common categorisation framework for Higgs analyses
- Effort in channels has just started yet
- Advantages: Minimize theory dependency, 'effortless' combination of measurements within different channels
- Will be important for property/coupling measurements in Run 2