Last iteration?

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Re-iterated with Frank P., …

Problem formulation

Experiments need: values, uncertainties, correlations for σ_{tot}, σ_0, σ_1, σ_2

We now discuss only theoretical uncertainties:

- these are typically evaluated by varying QCD scales
- other uncertainties are very important too and must be kept in mind, but we do not attempt to evaluate them here

Logic flow (1): theory

Theory: σ_{tot}, $\sigma_{\geq 1}$, $\sigma_{\geq 2}$ have uncorrelated uncertainties

This defines the number of independent nuisance parameters (3)

Total CS and its uncertainty come from YR: $\boldsymbol{\sigma}_{\mathbf{YR}}$ and $\boldsymbol{\varepsilon}_{\mathbf{YR}}$

This takes care of one of the three nuisance parameters; two – TBD

Logic flow (2): experiment

Where do we take σ_0, σ_1, σ_2 from?

These are defined as $\boldsymbol{\sigma_{YR}}\times f_0$, $\boldsymbol{\sigma_{YR}}\times f_1$, $\boldsymbol{\sigma_{YR}}\times f_2$, where

- f_0, f_1, and f_2 are evaluated by experiments using the full detector simulation (event generator Higgs p_T usually reweighted to match NNLO calculations)

- $f_0 + f_1 + f_2 = 1$

- i.e. there is only independent variable here; next we use f_0 and f_1

Logic flow (3): theory + experiment

Where do we get errors on f_0 and f_2 from?

1) Run HNNLO to get σ_{tot}, $\sigma_{\geq 1}$, $\sigma_{\geq 2}$
   with their errors $\boldsymbol{\varepsilon}_{tot}$, $\boldsymbol{\varepsilon}_{\geq 1}$, $\boldsymbol{\varepsilon}_{\geq 2}$

2) get ratios:

$$\rho_0 = (\sigma_{tot} - \sigma_{\geq 1}) / \sigma_{tot}$$
$$\rho_1 = (\sigma_{\geq 1} - \sigma_{\geq 12}) / \sigma_{tot}$$
$$\rho_2 = \sigma_{\geq 2} / \sigma_{tot}$$

3) Their errors are

$$\delta\rho_0 / \rho_0 = (1-\rho_0)/\rho_0 \text{ sqrt}((\varepsilon_{\geq 1})^2 + (\varepsilon_{tot})^2)$$
$$\delta\rho_1 / \rho_1 = \ldots$$
$$\delta\rho_2 / \rho_2 = \text{sqrt}((\varepsilon_{\geq 2})^2 + (\varepsilon_{tot})^2)$$

4) Use these together with the total CS uncertainty $\boldsymbol{\varepsilon}_{YR}$ to define uncertainties for 0-, 1-, 2-jet bins

BUT: $\delta\sigma_{YR}/\sigma_{YR}$, $\delta\rho_0/\rho_0$, $\delta\rho_0/\rho_0$, $\delta\rho_0/\rho_0$ are correlated and in principle there are also only three independent nuisance parameters

Logic flow (4): theory

What is the correlation matrix?

1) Use HNNLO to get correlation matrix for σ_{tot}, ρ_0, ρ_1, ρ_2

$$C(\sigma_{tot}, \rho_0) = 1 / \mathrm{sqrt}(1 + (\varepsilon_{\geq 1}/\varepsilon_{tot})^2)$$

$$C(\sigma_{tot}, \rho_1) = \ldots$$

$$C(\sigma_{tot}, \rho_2) = - 1 / \mathrm{sqrt}(1 + (\varepsilon_{\geq 2}/\varepsilon_{tot})^2)$$

$$C(\rho_0, \rho_2) = C(\sigma_{tot}, \rho_0) \times C(\sigma_{tot}, \rho_2)$$

$$C(\rho_1, \rho_2) = \ldots$$

NOTE: only ratios of relative errors of HNNLO CS's are needed

Logic flow (5): simplifying

1) The gg-contribution to the 2-jet analysis is strongly suppressed, nearly negligible

2) Numerically, the 2-jet gg uncertainties correlate very weakly with the total CS, 0-jet and 1-jet fractions.

If one wants to continue to keep track of the gg-contribution in the 2-jet analysis, it can be treated as uncorrelated with 0- and 1-jet bins

This will add fourth independent uncorrelated nuisance parameter---easy

Questions

- Are relative errors ε_{tot}, $\varepsilon_{\geq 1}$, $\varepsilon_{\geq 2}$ (HNNLO) approximately m_H independent?
  - **This would simplify tracking errors on ρ's**

- Are ratios of relative errors $(\varepsilon_{\geq 1}/\varepsilon_{tot})$ and $(\varepsilon_{\geq 2}/\varepsilon_{tot})$ (HNNLO) approximately m_H independent?
  - **This would simplify tracking correlation matrix**

If we are lucky, maybe, we can get away with a one-size-fits-all approach (with some simplifications)

Backup

ggF Jet Bin Correlation

Basic parton level selection using HNNLO

- Two leptons with pT>20 GeV and |η|<2.5;
- MissingEt > 30 GeV (pT of the two neutrino system);
- Event veto if jets with pT>30 GeV and |η|<3.0

	$(\mu_F/m_H,\ \mu_R/m_H)$								
	(0.5, 0.5)	(0.5, 1.0)	(0.5, 2.0)	(1.0, 0.5)	(1.0, 1.0)	(1.0, 2.0)	(2.0, 0.5)	(2.0, 1.0)	(2.0, 2.0)
	Cross sections in 0, 1 and 2-jet bin								
σ_0	30.1	28.5	26.6	30.1	28.6	26.8	30.3	28.6	27.0
σ_1	11.5	10.2	8.86	11.6	10.2	8.77	11.7	10.1	8.60
σ_2	3.95	2.64	1.84	3.57	2.39	1.66	3.24	2.17	1.51
	Fractions in 0, 1 and 2-jet bin								
f_0	66.1	68.9	71.4	66.5	69.5	72.0	67.0	70.0	72.8
f_1	25.2	24.7	23.7	25.6	24.7	23.6	25.9	24.7	23.2
f_2	8.69	6.40	4.92	7.88	5.80	4.45	7.17	5.31	4.06

f_j correlation matrix

$$\begin{pmatrix} 1.00 & -0.95 & -0.98 \\ -0.95 & 1.00 & 0.88 \\ -0.98 & 0.88 & 1.00 \end{pmatrix}$$

- f_0 anti-correlated with f_1 and f_2;
- f_1 and f_2 are largely correlated