ATLAS Jet-Veto study in Run 1 and Wishlist for Run-II

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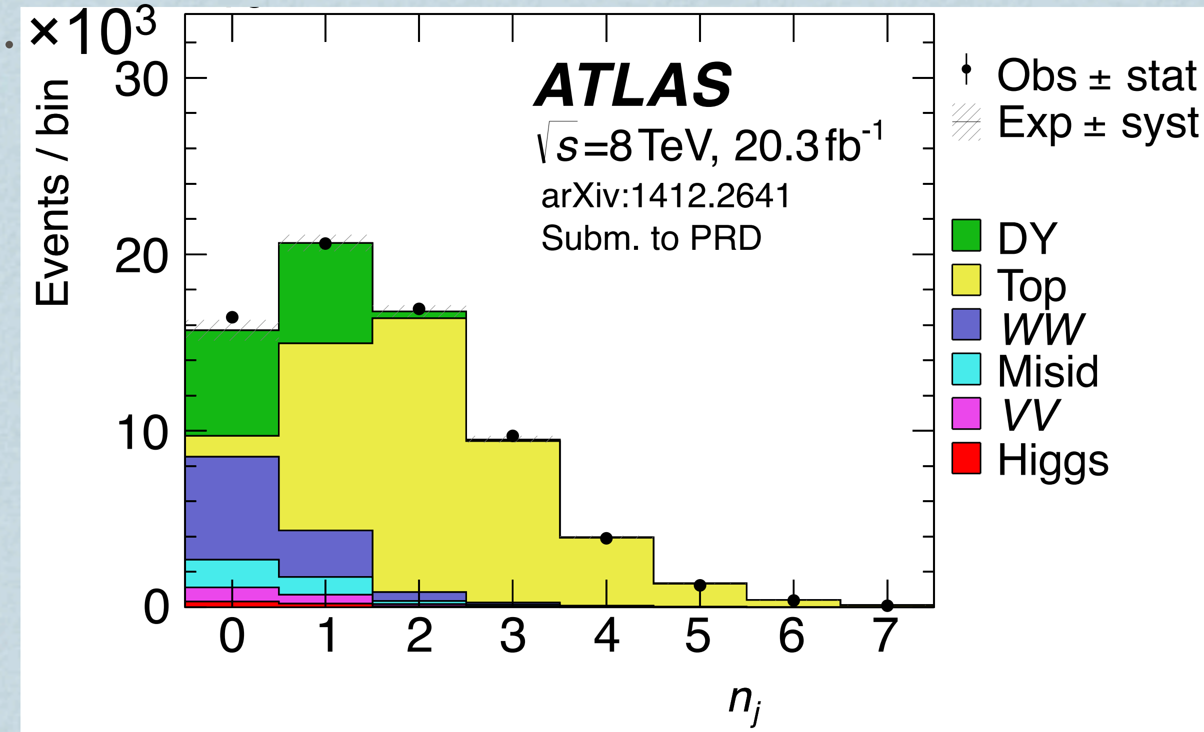
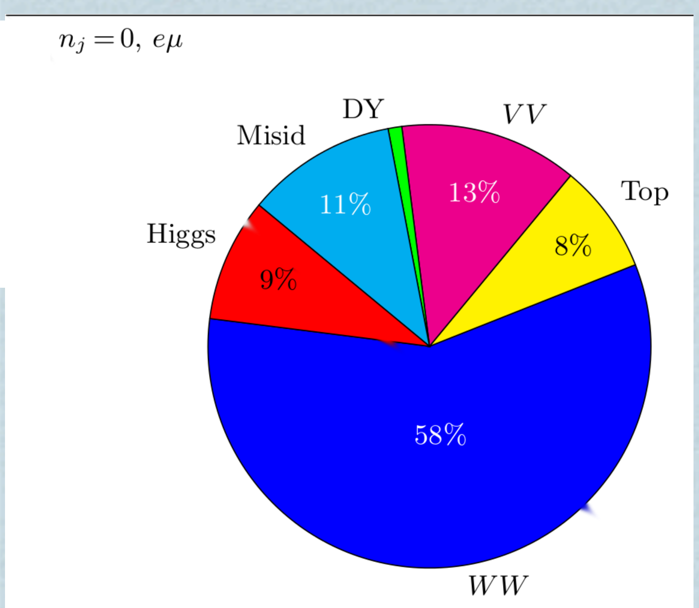
Jet veto for background supression.

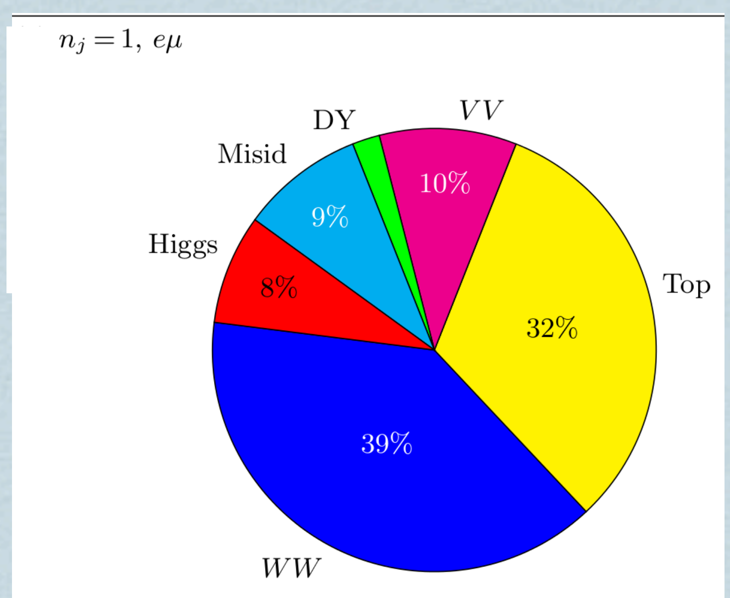
The case of $H \to WW^* \to l\nu l\nu$ (arXiv:1412.2641), that is the most affected by such uncertainties.

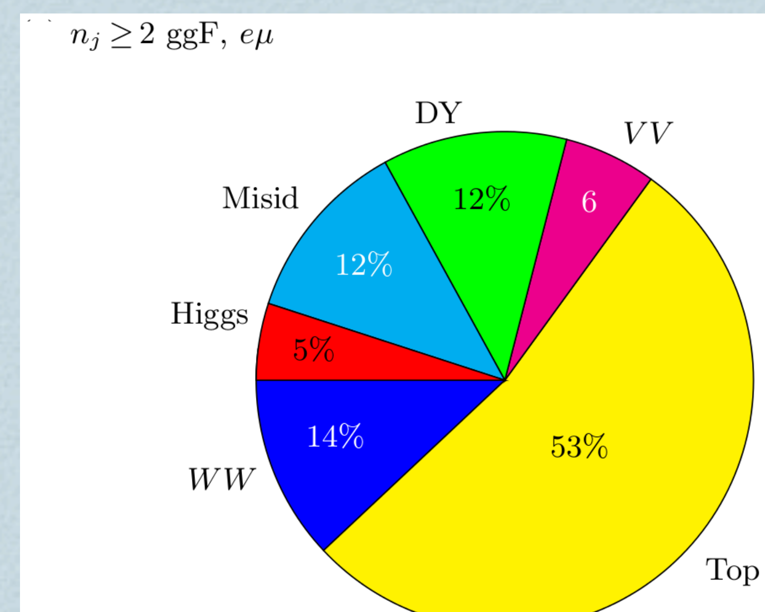


- Large background from $pp \to t\bar{t} \to W^+W^-b\bar{b} \to l^+\nu l^-\bar{\nu}b\bar{b}$ producing at least 2 b-jets plus additional light jets from QCD radiation.

The top background impact is strongly reduced by binning the analysis in jet bins (final selection, background normalised with data driven estimates)



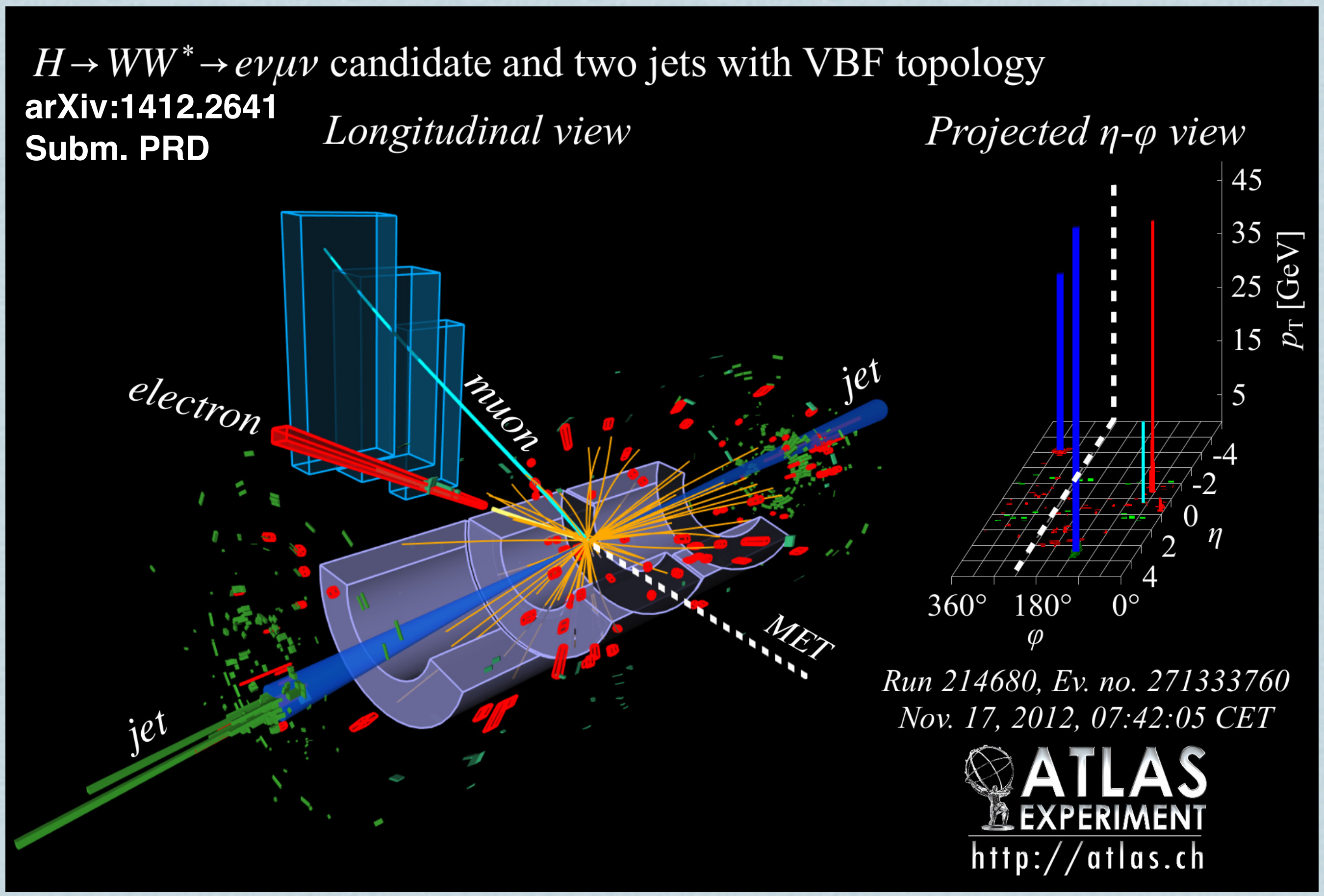


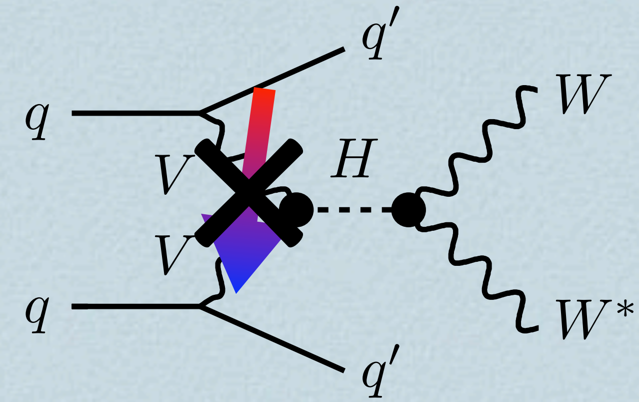


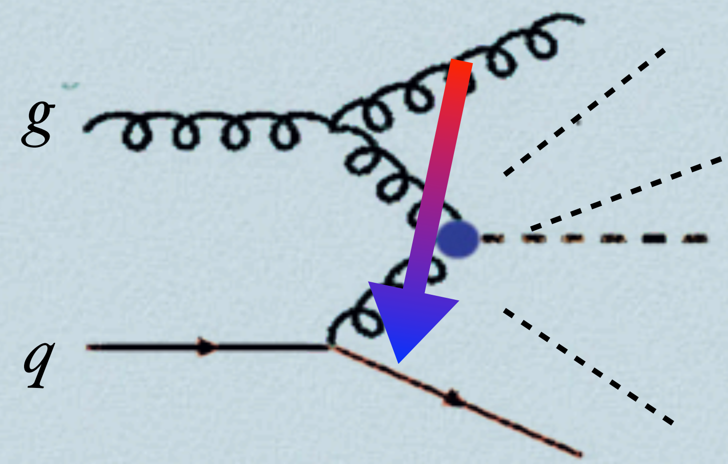
Jet veto for Higgs background suppression.

"Yesterday's sensation is today's calibration and tomorrow's background." - R. Feynman

ggF discovery γγ/ZZ mass split ggF in VBF







no jet in between.

Central Jet Veto: no jets with p_T > 20 GeV between the tagging jets ($y_{tag^1} < y < y_{tag^2}$).

Estimating higher order uncertainties.

Renormalisation scale ansatz.

$$\sigma_{\text{tot}} \sim \alpha_S^k \{1 \qquad + \alpha_S \qquad + \alpha_S^2 \qquad + \mathcal{O}(\alpha_S^3)\}$$

α_s is computed at a paricular scale that depends from the process $\alpha_s(\mu_R)$
μ_R: renormalization scale

scale uncertainty sillogism

full expantion available → no μ_R dependence

big contribution from higher order terms ← large μ_R dependence

σ_{tot} depends on μ_R through $\alpha_s(\mu_R)$

Scale uncertainty with Jet Veto.

[YR2 and W. Stewart, J. Tackmann, PRD85, 034011 (2012)]

Let's assume to veto any jet with p_T > 25 GeV (ggF) or 20 GeV (VBF, CJV).

$$\sigma_{\rm tot} = \sigma_0\big(p_T^{\rm cut}\big) + \sigma_{\geq 1}\big(p_T^{\rm cut}\big)$$

$$\begin{aligned} \sigma_{\rm tot} &\sim \alpha_S^k\{1 \quad +\alpha_S \quad +\alpha_S^2 \quad +\mathcal{O}\big(\alpha_S^3\big)\} \\ \sigma_{\geq 1} &\sim \alpha_S^k\{ \quad \alpha_S(L^2+L+1) \quad +\alpha_S^2(L^4+L^3+L^2+L+1) \quad +\mathcal{O}\big(\alpha_S^3 L^6\big)\} \end{aligned}$$

$L \sim \ln\left(p_T^{\rm cut}/Q\right)$ Q ~ m_H (in the Higgs case)

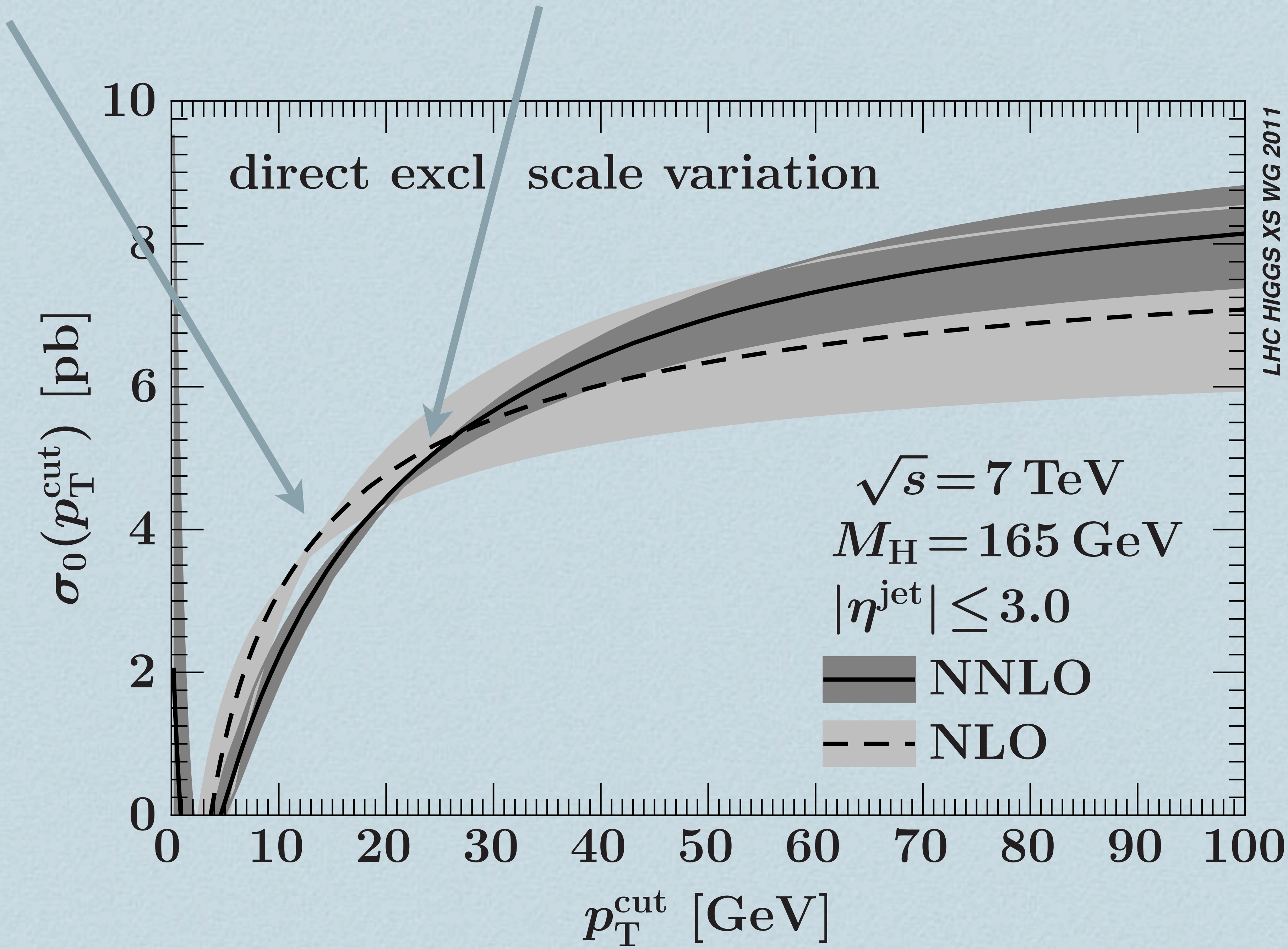
α_s multiplies large logarithms, therefore scale uncertainties give an idea of the size of the missing terms.

$$\begin{aligned} \sigma_0(p^{\rm cut}) &= \sigma_{\rm total} - \sigma_{\geq 1}(p^{\rm cut}) \\ &\simeq \sigma_B\Big\{\big[1+\alpha_s+\alpha_s^2+\mathcal{O}(\alpha_s^3)\big] - \big[\alpha_s(L^2+L+1)+\alpha_s^2(L^4+L^3+L^2+L+1)+\mathcal{O}(\alpha_s^3 L^6)\big]\Big\} \end{aligned}$$

There are cancellations among α_s and the logarithms, depending on the $p_T^{\rm cut}$ we can tune the α_s dependence to zero.

Cancellation effects in scale variation.

Cancellation happens for different threshold values depending on the perturbative order.



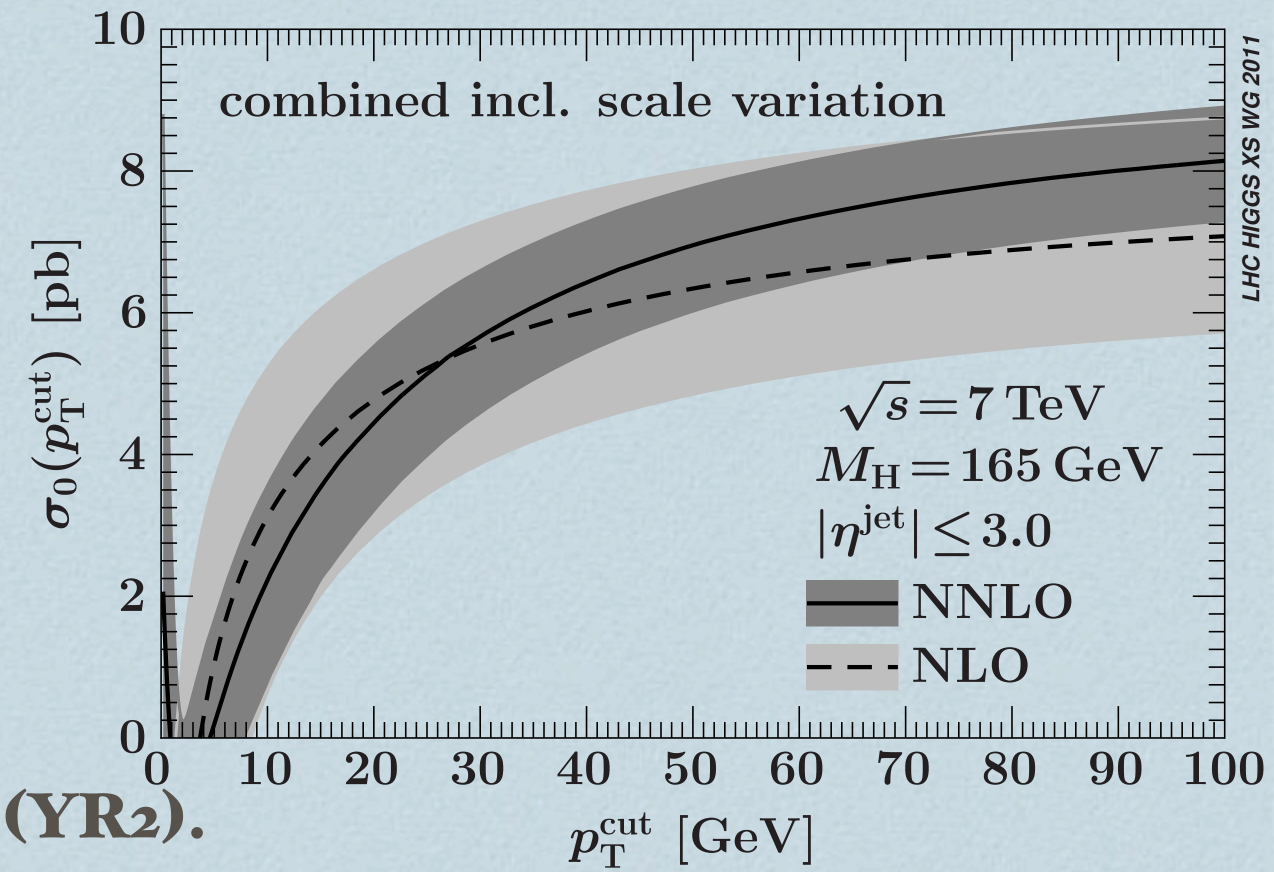
How to solve the problem..

Stewart-Tackman prescription.

assume uncorrelated scale uncertainties between σ_{total} and $\sigma_{\geq 1}$.

$$\sigma_0(p^{cut}) = \sigma_{total} - \sigma_{\geq 1}(p^{cut})$$
$$\delta^2\sigma_0\left(p^{cut}\right) = \delta^2\sigma_{total} + \delta^2\sigma_{\geq 1}\left(p^{cut}\right)$$

cancellation doesn't happen by definition because we sum up uncertainties.



Jet Veto Efficiency method prescription (YR2).

$$f_0^{(a)}(p_T^{cut}) \equiv \frac{\sigma_0^{(0)}(p_T^{cut}) + \sigma_0^{(1)}(p_T^{cut}) + \sigma_0^{(2)}(p_T^{cut})}{\sigma^{(0)} + \sigma^{(1)} + \sigma^{(2)}}$$

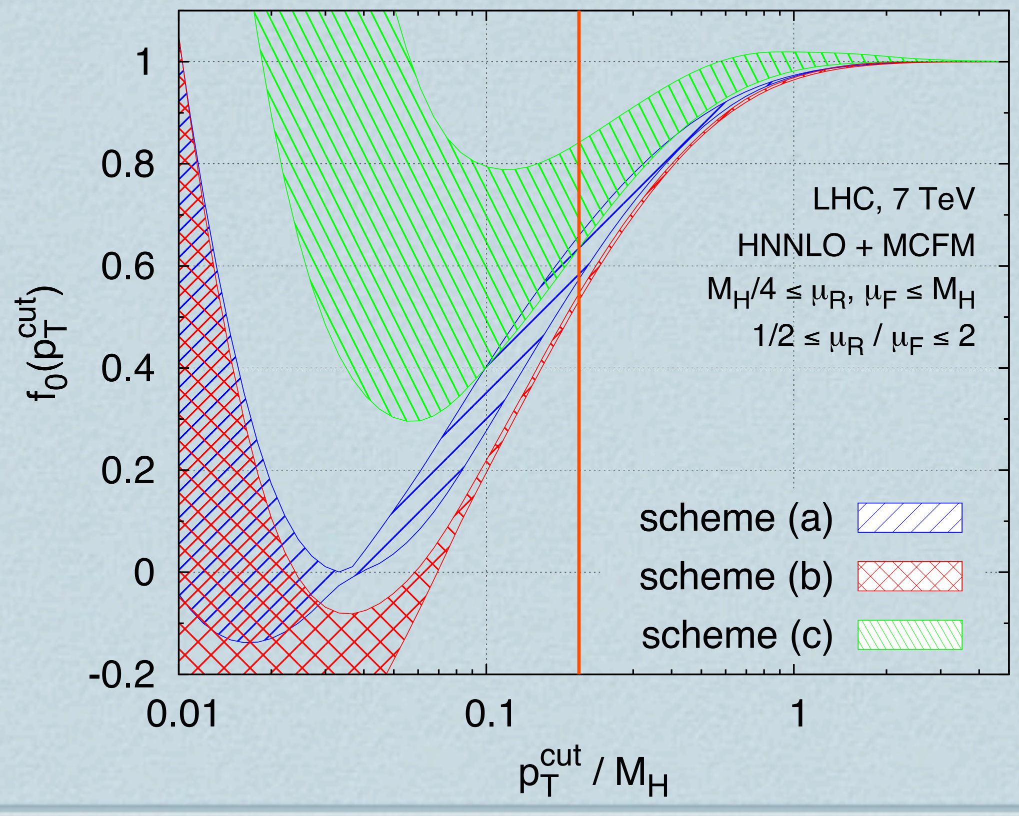
$$f_0^{(b)}(p_T^{cut}) = 1 - \frac{\sigma_{\text{1-jet}}^{\text{NLO}}(p_T^{cut})}{\sigma^{(0)} + \sigma^{(1)}}$$

$$f_0^{(c)}(p_T^{cut}) = 1 - \frac{\sigma_{\text{1-jet}}^{\text{NLO}}(p_T^{cut})}{\sigma^{(0)}} + \frac{\sigma^{(1)}}{(\sigma^{(0)})^2}\sigma_{\text{1-jet}}^{\text{LO}}(p_T^{cut})$$

differ by α_s^3 terms.

f: jet veto efficiency

take the largest between scale variation and differences among schemes as uncertainty. Uncorrelate uncertainties between σ_{total} and f.



Comparing JVE to S&T at fixed order.

S&T m_H = 125 GeV

	i	$f_i = \sigma_i/\sigma_{tot}$	σ_i (pb)	$\Delta\sigma_i/\sigma_i$
	≥0	-	19.3	8%
	≥1	-	7.44	20%
exclusive	0	0.61	12	18%

JVE

i	$f_i = \sigma_i/\sigma_{tot}$	σ_i (pb)	$\Delta f_i/f_i$
≥0	-	19.3	8%
0	0.61	7.44	22%
0	0.61	12	23%

At fixed order JVE gives larger uncertainties than S&T [a very good motivation to not use it :-)]

Comparing JVE to S&T at fixed order.

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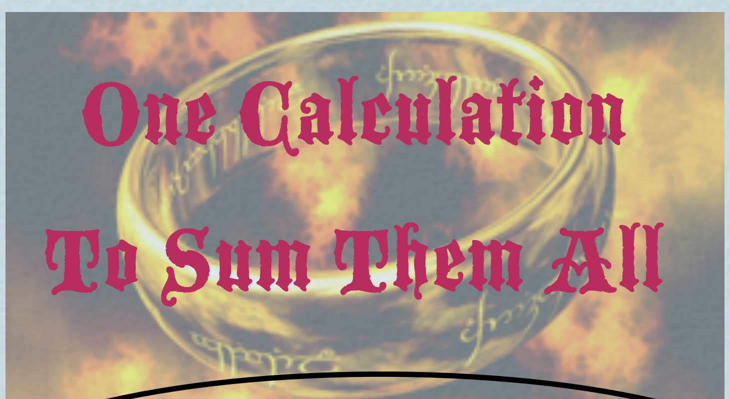
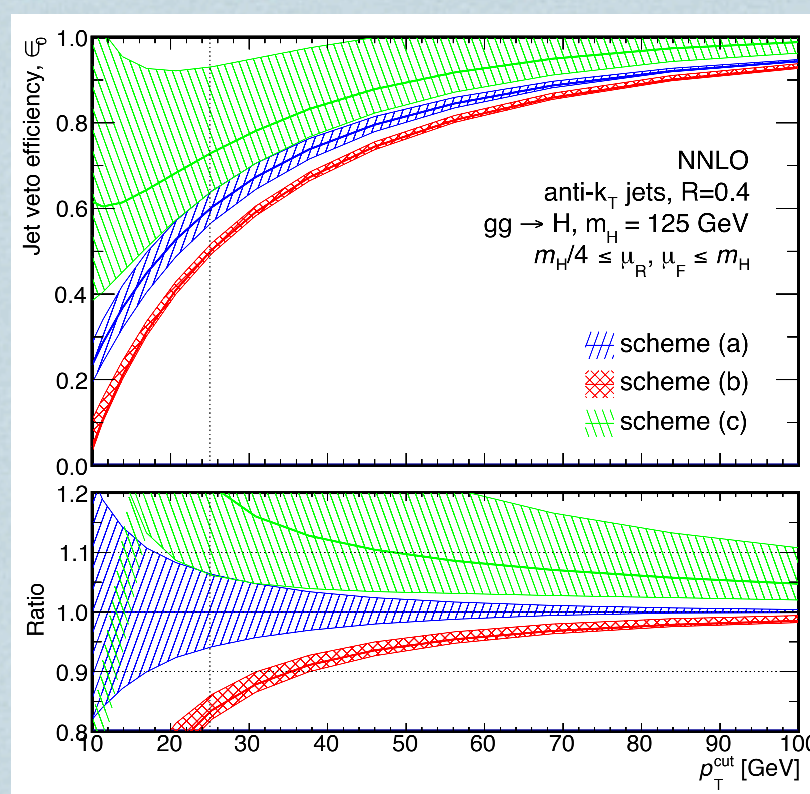
At fixed order JVE gives larger uncertainties than S&T [a very good motivation to not use it :-)]   But recently new resummed calculation of ε_0 became available.

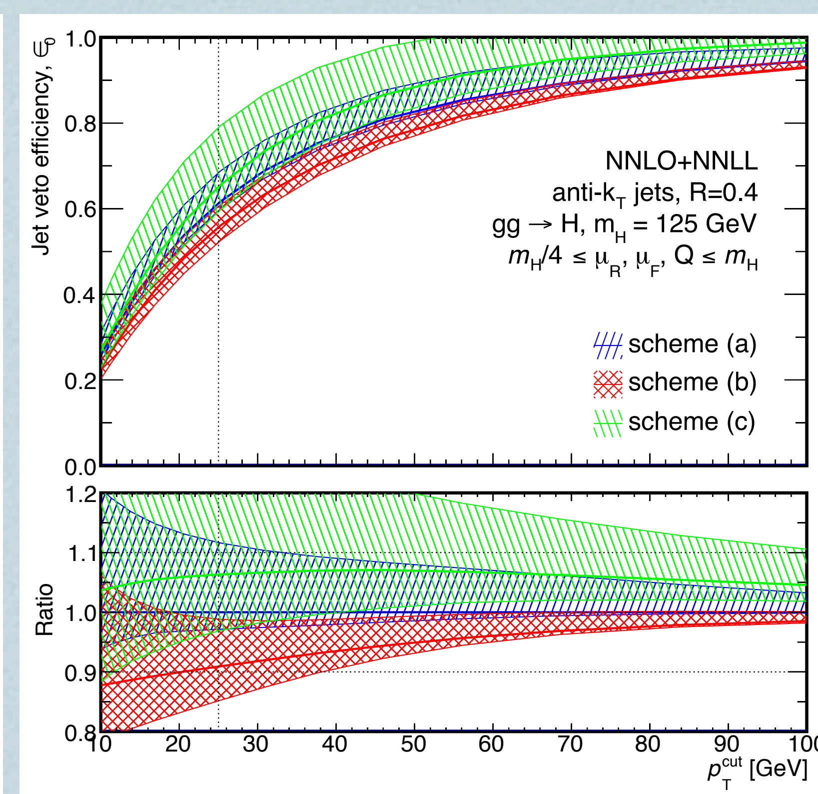


$$\sigma_{\geq 1} \sim \alpha_S^k\{ \quad \alpha_S(L^2+L+1) \quad + \quad +\alpha_S^2(L^4+L^3+L^2+L+1) \quad +\mathcal{O}(\alpha_S^3 L^6)\}$$

schemse a,b,c corresponds to the matching of the resummed calculation with the finite order one.

A. Banfi et al., PRL 109, 202001 (2012)





Comparing JVE to S&T at fixed order.

S&T

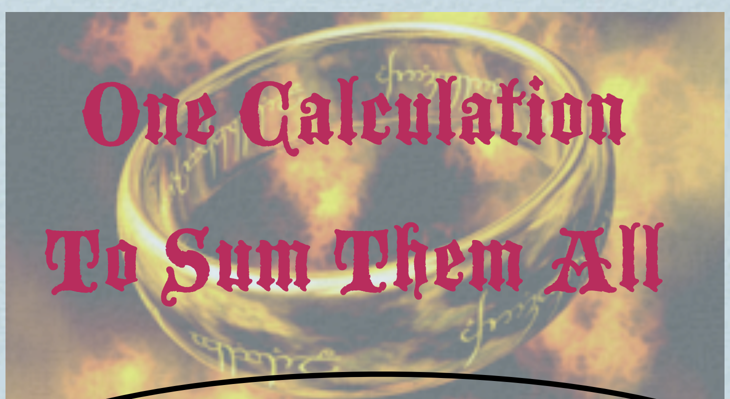
m_H = 125 GeV

	i	$f_i=\sigma_i/\sigma_{tot}$	σ_i (pb)	$\Delta\sigma_i/\sigma_i$
	≥0	-	19.3	8%
	≥1	-	7.44	20%
exclusive	0	0.61	12	18%

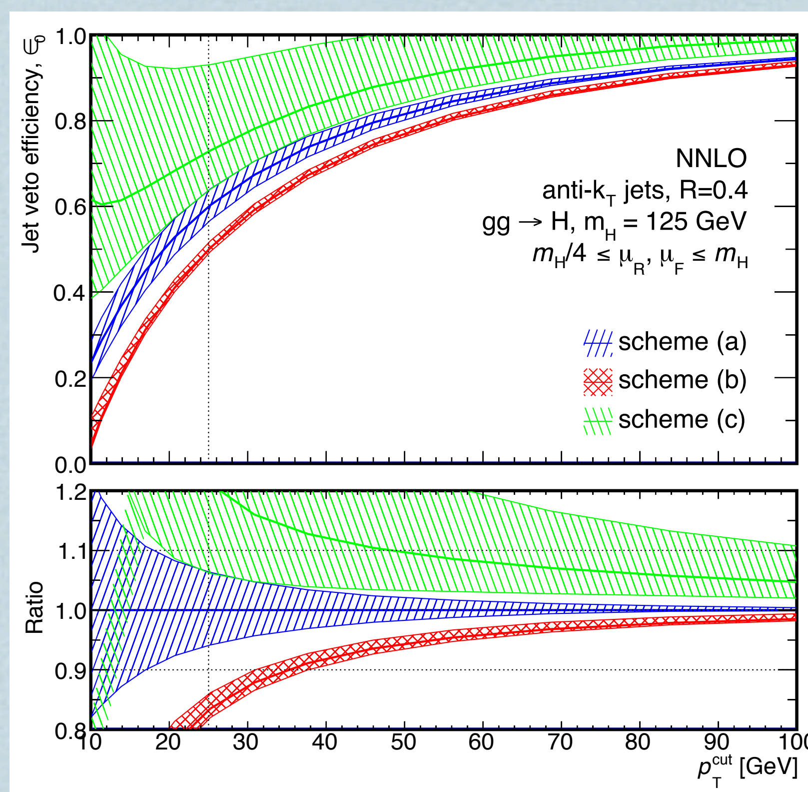
JVE (resummed)

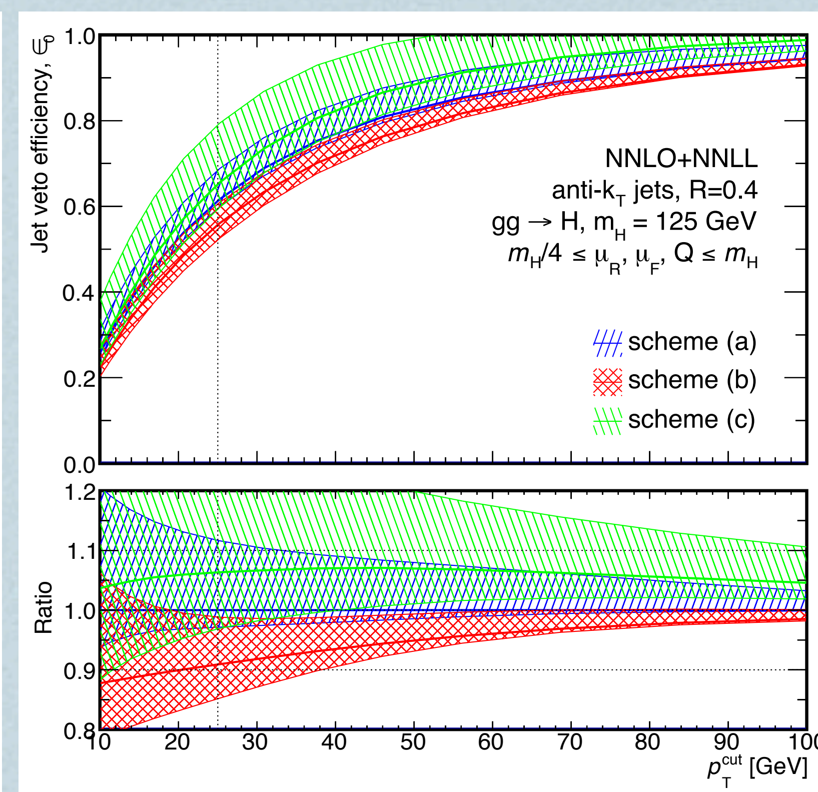
i	$f_i=\sigma_i/\sigma_{tot}$	σ_i (pb)	$\Delta f_i/f_i$
≥0	-	19.3	8%
0	0.61	7.44	12%
0	0.61	12	14%

At fixed order JVE gives larger uncertainties than S&T [a very good motivation to not use it :-)]   But recently new resummed calculation of ε_0 became available.



$$\sigma_{\geq 1} \sim \alpha_S^k \{ \quad \alpha_S (L^2 + L + 1) \quad + \\ + \alpha_S^2 (L^4 + L^3 + L^2 + L + 1) \quad + \mathcal{O}(\alpha_S^3 L^6) \}$$

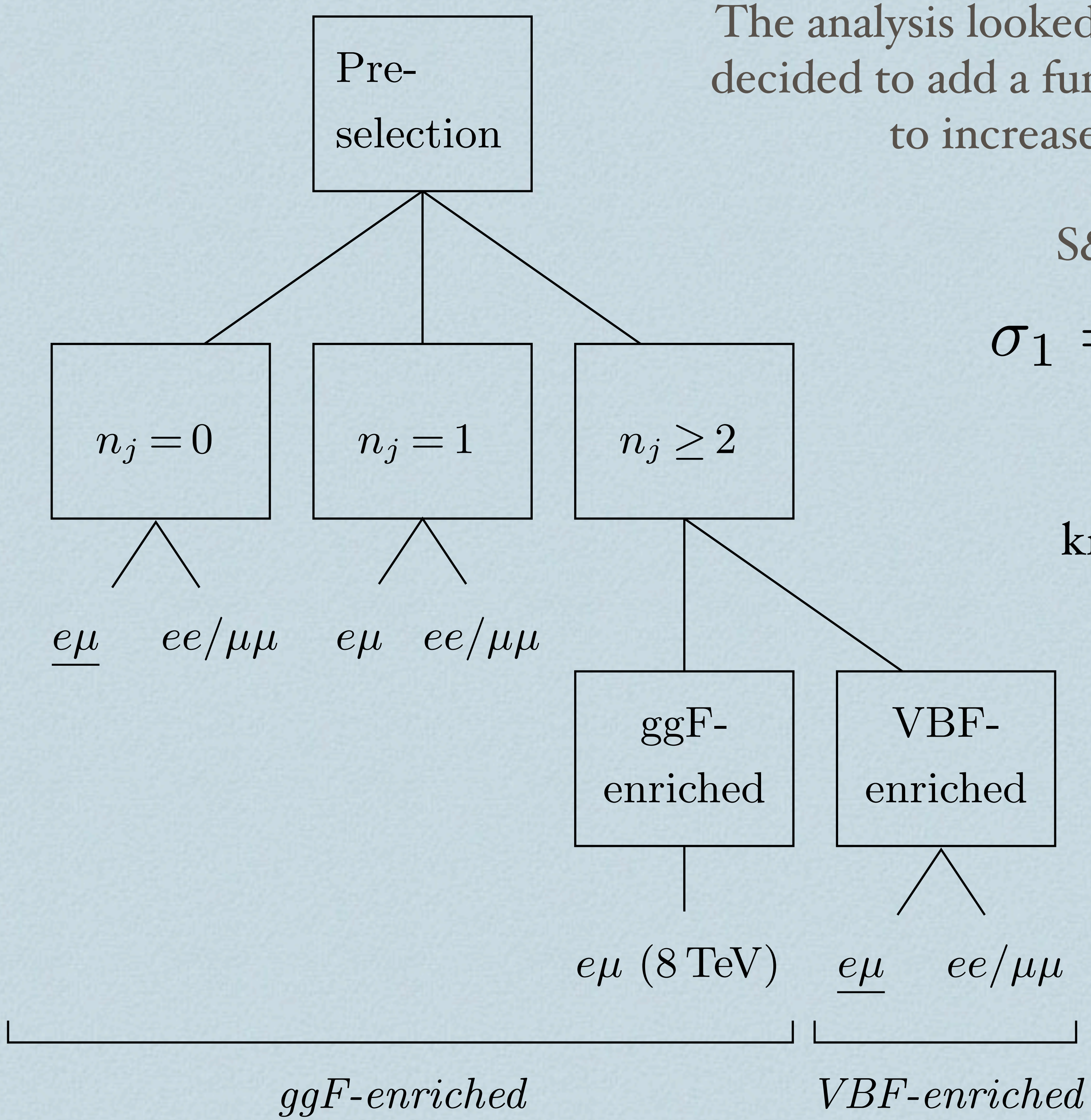




schemse a,b,c corresponds to the matching of the resummed calculation with the finite order one.

A. Banfi et al., PRL 109, 202001 (2012)

Going beyond 0 jet.



The analysis looked too much simpe, so ATLAS decided to add a further 2 jet, non VBF category to increase the ggF sensitivity.

S&T implies:

$$\sigma_1 = \sigma_{\geq 1} - \sigma_{\geq 2}$$

known up to α_s^4

known up to α_s^5

A good expansion doesn't mix different orders:

use $\sigma_{\geq 2}$ up to α_s^4 (~70% uncertainty)

same uncertainty in 2 jets to preserve the total cross section.

Extension to multi-jets.

[D. Hall thesis, CERN-THESIS-2014-130]

S&T

i	$f_i=\sigma_i/\sigma_{tot}$	σ_i (pb)	$\Delta\sigma_i/\sigma_i$
≥0	-	19.3	8%
≥1	-	7.4	20%
≥2	-	2.3	70%
0	0.61	12	18%
1	0.27	5.2	43%
≥2	0.12	2.3	70%

$$\sigma_0 = \sigma_{\geq 0} - \sigma_{\geq 1}$$
$$\delta^2\sigma_0 = \delta^2\sigma_{\geq 0} + \delta^2\sigma_{\geq 1}$$

$$\sigma_1 = \sigma_{\geq 1} - \sigma_{\geq 2}$$
$$\delta^2\sigma_1 = \delta^2\sigma_{\geq 1} + \delta^2\sigma_{\geq 2}$$

$$\delta^2\sigma_{\geq 2}$$

JVE (extension from the 0 jet case)

$$\epsilon_1^{(a)} = 1 - \frac{\sigma_{\geq 2}^{\mathrm{NLO}}}{\sigma_{\geq 1}^{\mathrm{NNLO}}} \qquad \epsilon_1^{(b)} = 1 - \frac{\sigma_{\geq 2}^{\mathrm{NLO}}}{\sigma_{\geq 1}^{\mathrm{NLO}}}$$

Missing.

$$\epsilon_1^{(c)} = 1 - \frac{\sigma_{\geq 2}^{\mathrm{NLO}}}{\sigma_{\geq 1}^{\mathrm{LO}}} + \left(\frac{\sigma_{\geq 1}^{\mathrm{NLO}}}{\sigma_{\geq 1}^{\mathrm{LO}}} - 1\right)\frac{\sigma_{\geq 2}^{\mathrm{LO}}}{\sigma_{\geq 1}^{\mathrm{LO}}}$$

Resummation missing

In the 0 jet case $\varepsilon_0^{(b)} < \varepsilon_0^{(a)} < \varepsilon_0^{(c)}$, assuming that this is preserved in 1 jet, we don't really need (a).

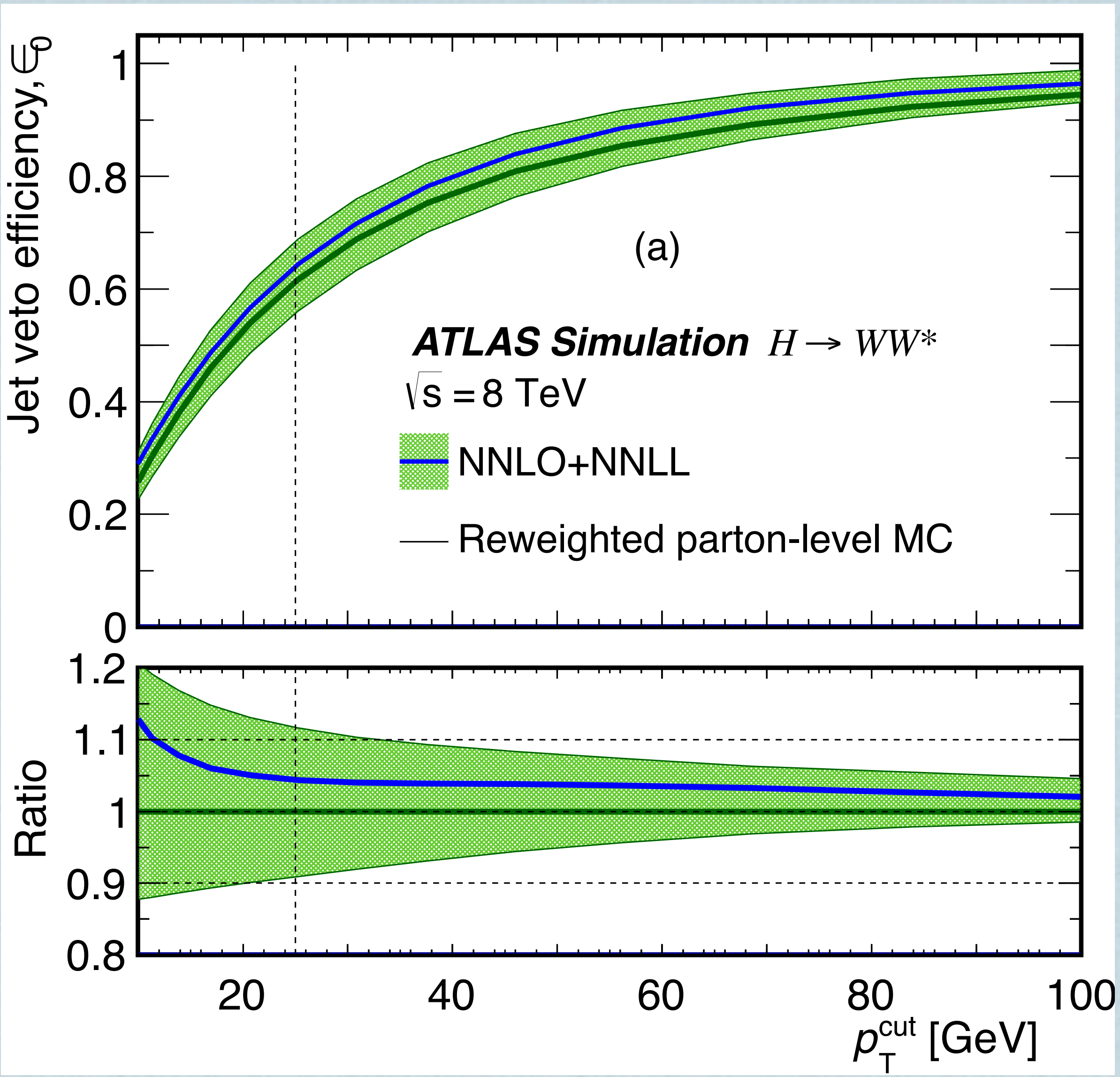
Assumption verified for $\sigma_{1\text{-jet}}^{\mathrm{NNLO}}$ gg only using Petriello (arXiv:1302.6216)

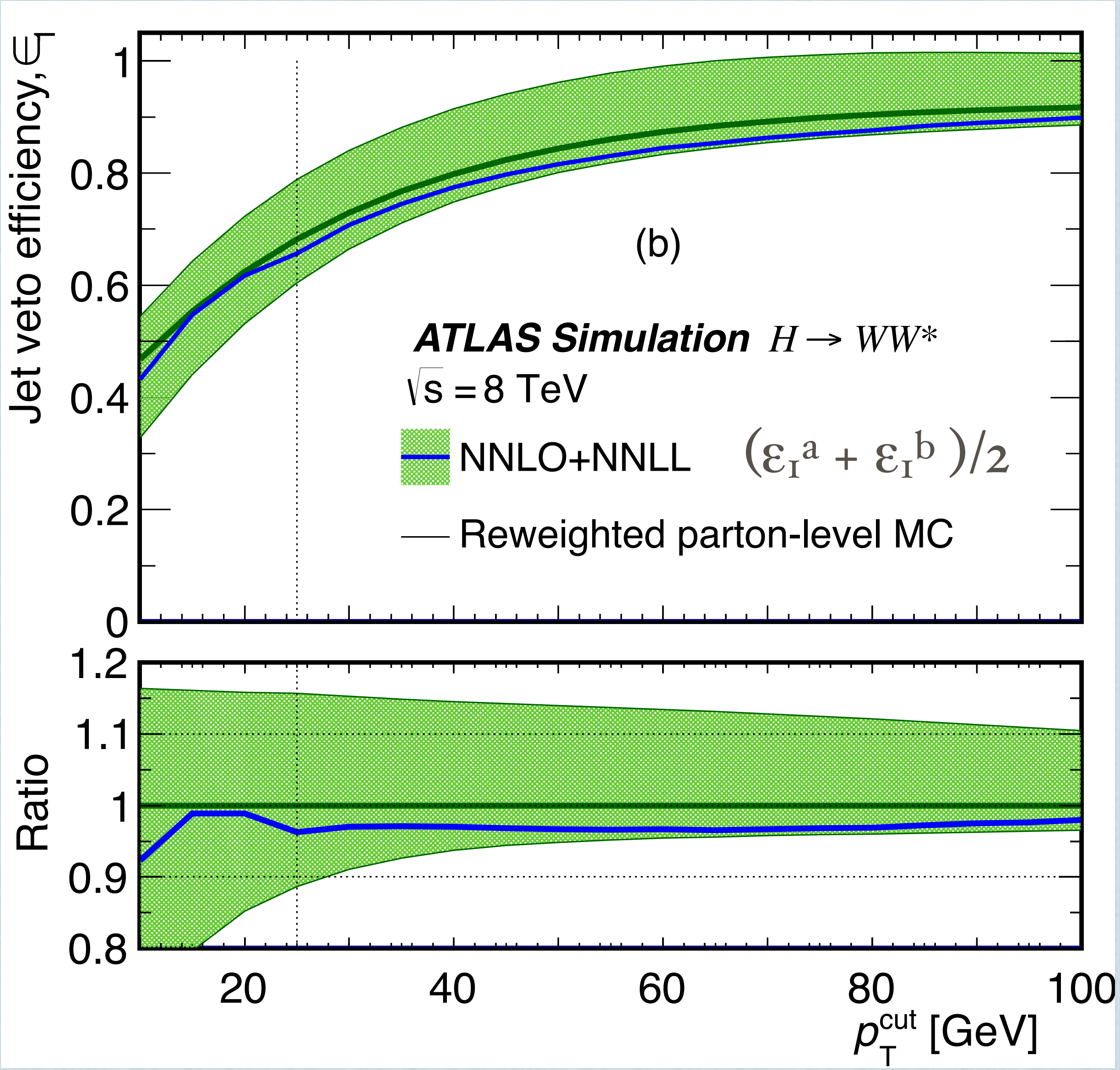
$$\epsilon_1^{(a)} = 0.831 \quad \epsilon_1^{(b)} = 0.761 \quad \epsilon_1^{(c)} = 0.843$$

Procedure to estimate ε_1 uncertainty:

Take the envelope among $[\varepsilon_1(b)+\varepsilon_1(c)]/2$ scale uncertainties, $\varepsilon_1(b)$ and $\varepsilon_1(c)$.

ε_0 and ε_1 curves.





Extension to multi-jets.

S&T

i	$f_i=\sigma_i/\sigma_{tot}$	σ_i (pb)	$\Delta\sigma_i/\sigma_i$
≥0	-	19.3	8%
≥1	-	7.4	20%
≥2	-	2.3	70%
0	0.61	12	18%
1	0.27	5.2	43%
≥2	0.12	2.3	70%

$$\sigma_0 = \sigma_{\geq 0} - \sigma_{\geq 1}$$
$$\delta^2\sigma_0 = \delta^2\sigma_{\geq 0} + \delta^2\sigma_{\geq 1}$$

$$\sigma_1 = \sigma_{\geq 1} - \sigma_{\geq 2}$$
$$\delta^2\sigma_1 = \delta^2\sigma_{\geq 1} + \delta^2\sigma_{\geq 2}$$

$$\delta^2\sigma_{\geq 2}$$

Use HNNLO LO cross section.

JVE

i	val	Δval/val
$\sigma_{\geq 0}$	19.3 pb	8%
f_0	0.61	12%
f_1	0.69	15%

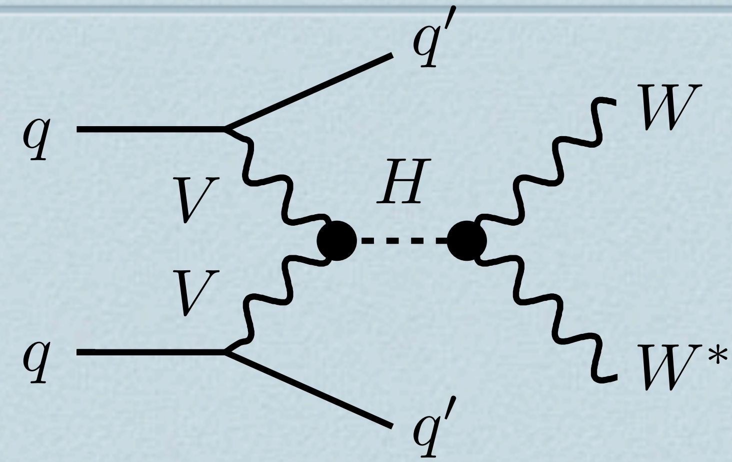
i	$f_i=\sigma_i/\sigma_{tot}$	σ_i (pb)	$\Delta\sigma_i/\sigma_i$
0	0.61	12	14%
1	0.27	5.2	25%
≥2	0.12	2.3	39%

$$\epsilon_1^{(b)} = 1 - \frac{\sigma^{NLO}_{\geq 2}}{\sigma^{NLO}_{\geq 1}} \qquad \epsilon_1^{(c)} = 1 - \frac{\sigma^{NLO}_{\geq 2}}{\sigma^{LO}_{\geq 1}} + \left(\frac{\sigma^{NLO}_{\geq 1}}{\sigma^{LO}_{\geq 1}} - 1\right)\frac{\sigma^{LO}_{\geq 2}}{\sigma^{LO}_{\geq 1}}$$

Use MCFM NLO cross section.

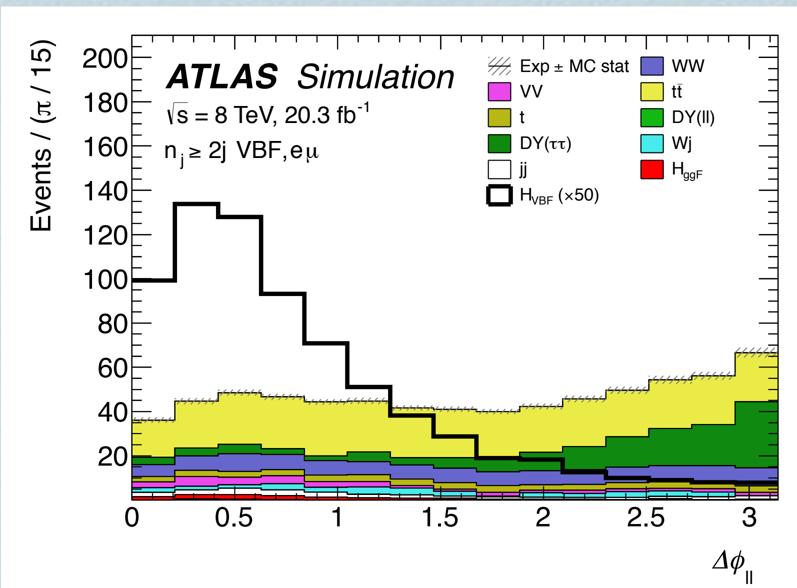
Source	Observed $\mu = 1.09$ Error +	−	Plot of error (scaled by 100)	Observed $\mu_{ggF} = 1.02$ Error +	−	Plot of error (scaled by 100)
Data statistics	0.16	0.15		0.19	0.19	
Signal regions	0.12	0.12		0.14	0.14	
Profiled control regions	0.10	0.10		0.12	0.12	
Profiled signal regions	-	-	-	0.03	0.03	
MC statistics	0.04	0.04		0.06	0.06	
Theoretical systematics	0.15	0.12		0.19	0.16	
Signal $H \to WW^* \mathcal{B}$	0.05	0.04		0.05	0.03	
Signal ggF cross section	0.09	0.07		0.13	0.09	
Signal ggF acceptance	0.05	0.04		0.06	0.05	
Signal VBF cross section	0.01	0.01		-	-	-
Signal VBF acceptance	0.02	0.01		-	-	-
Background WW	0.06	0.06		0.08	0.08	
Background top quark	0.03	0.03		0.04	0.04	
Background misid. factor	0.05	0.05		0.06	0.06	
Others	0.02	0.02		0.02	0.02	
Experimental systematics	0.07	0.06		0.08	0.08	
Background misid. factor	0.03	0.03		0.04	0.04	
Bkg. $Z/\gamma^* \to ee, \mu\mu$	0.02	0.02		0.03	0.03	
Muons and electrons	0.04	0.04		0.05	0.04	
Missing transv. momentum	0.02	0.02		0.02	0.01	
Jets	0.03	0.02		0.03	0.03	
Others	0.03	0.02		0.03	0.03	
Integrated luminosity	0.03	0.03		0.03	0.02	
Total	0.23	0.21		0.29	0.26	
			-30 -15 0 15 30			-30 -15 0 15 30

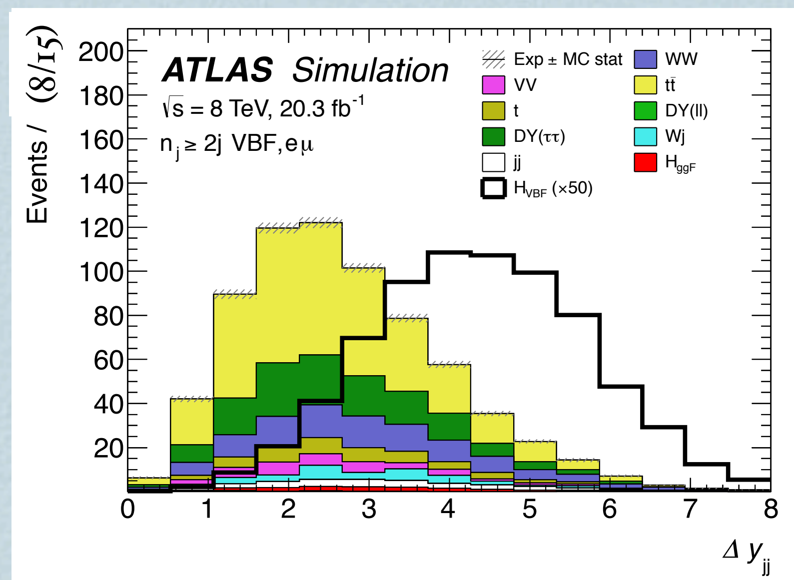
Acceptance systematics about 1/2 of total cross section systematics.

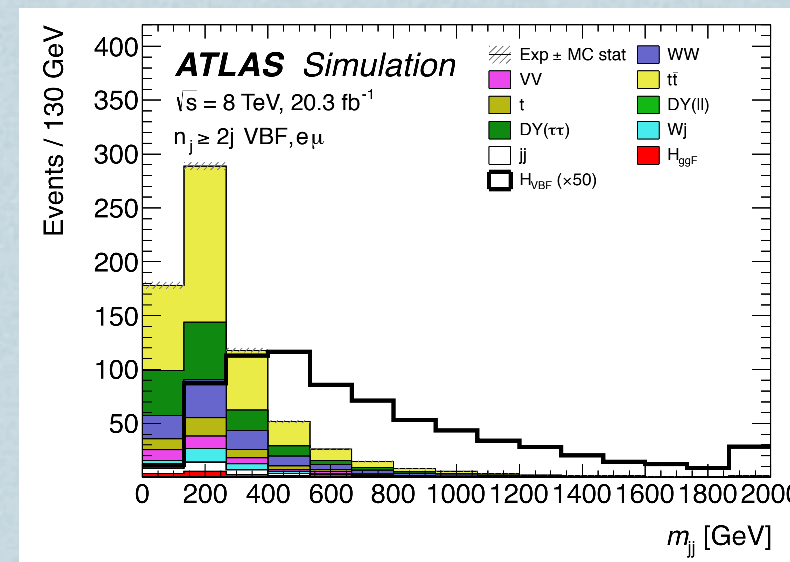


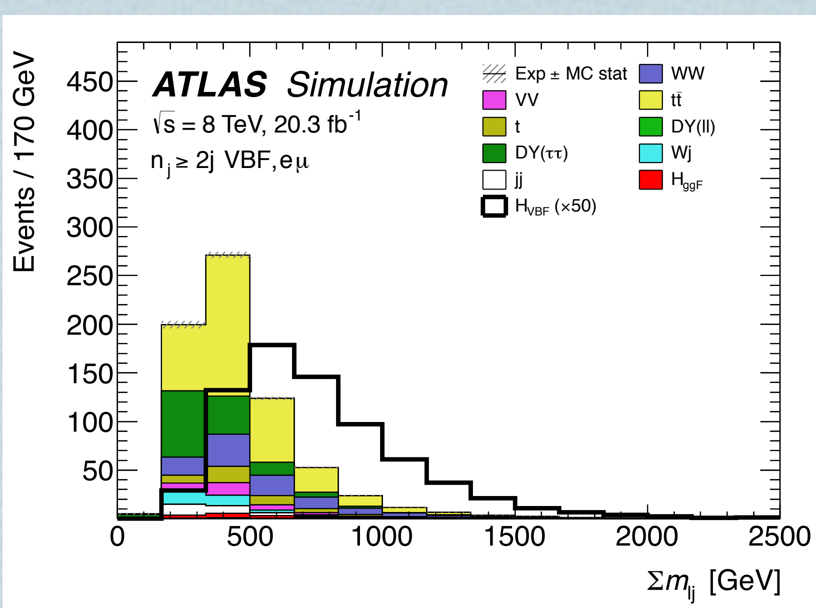
The VBF BDT analysis 1/2.

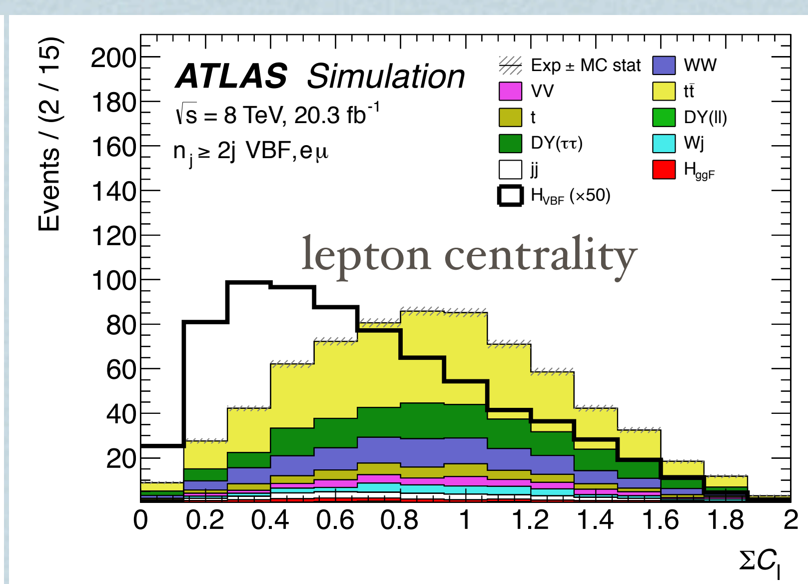
VBF topology probed using several variables exploiting differences between the Higgs VBF production and the main $t\bar{t}$ background that are used as inputs to the BDT.

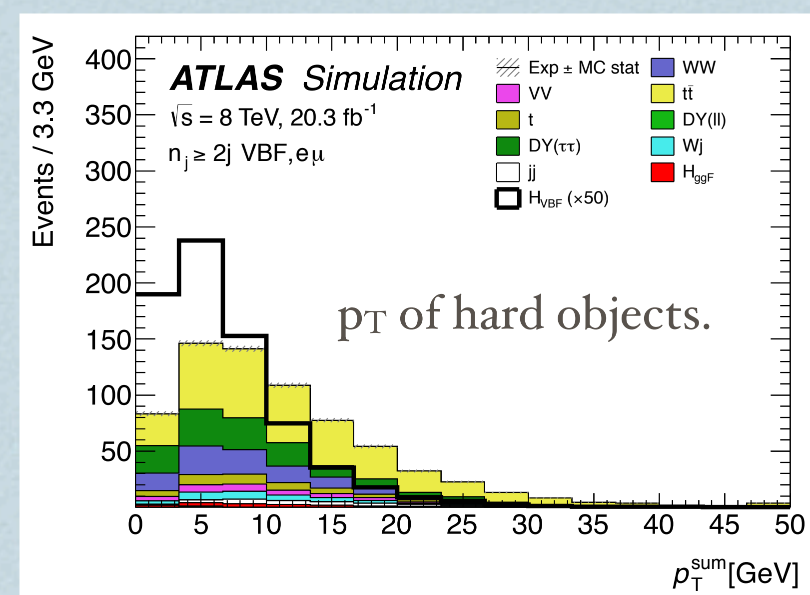










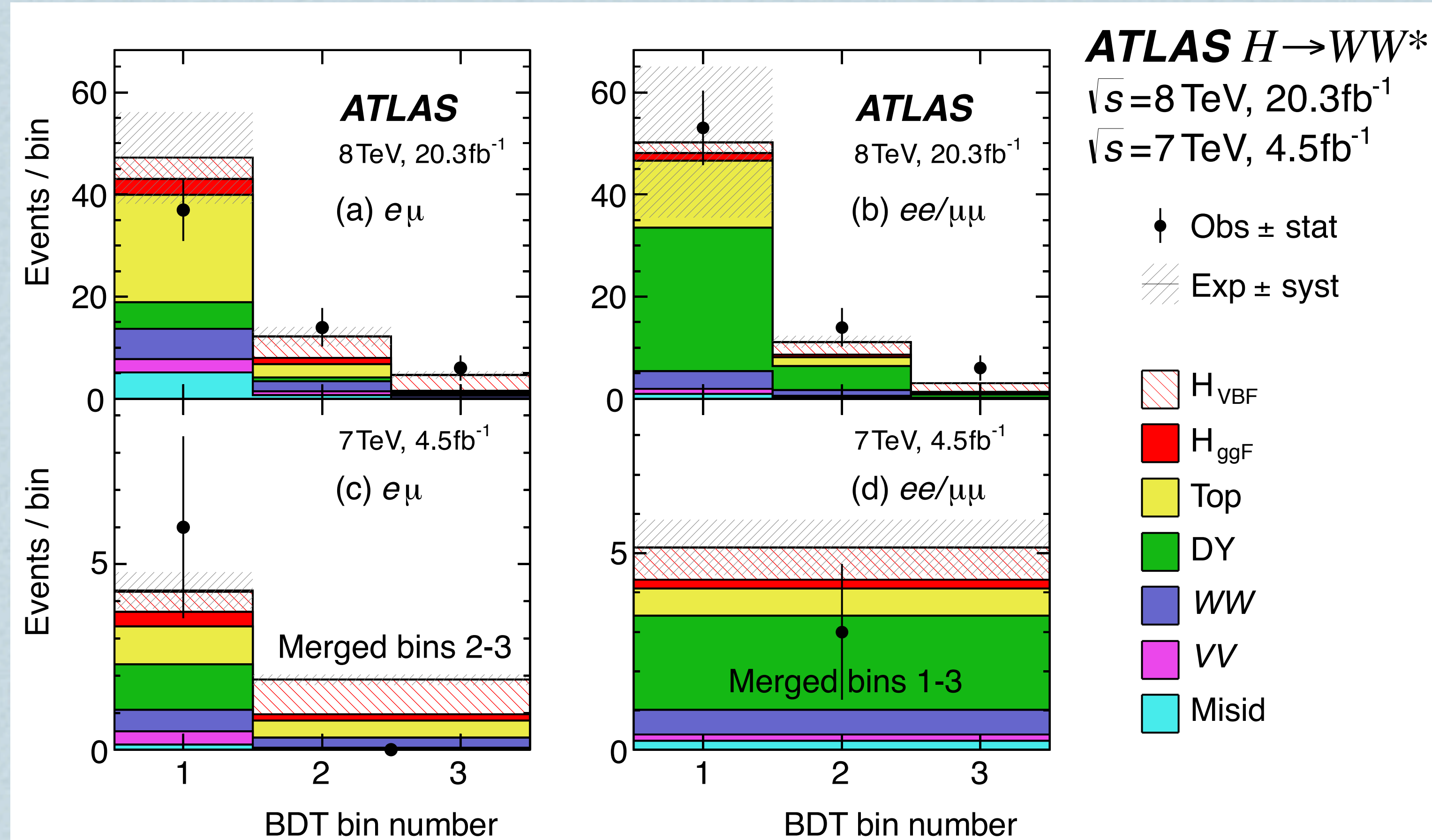


The VBF BDT analysis 2/2.

CJV performance (cross check analysis)

Selection	Summary $N_{\mathrm{obs}}/N_{\mathrm{bkg}}$	N_{obs}	N_{bkg}	N_{signal} N_{ggF}	N_{VBF}	N_{VH}
$m_{jj} > 600$	1.31 ± 0.12	131	100	2.3	8.2	-
$\Delta y_{jj} > 3.6$	1.33 ± 0.13	107	80	2.1	7.9	-
$C_{j3} > 1$	1.36 ± 0.18	58	43	1.3	6.6	

~ factor 2 reduction thanks to CJV in VBF phase space.



ggF is the largest background in the most sensitive bin (we need to correctly assign systematics to CJV)

Selection	Summary $N_{\mathrm{obs}}/N_{\mathrm{bkg}}$	N_{obs}	N_{bkg}	N_{signal} N_{ggF}	N_{VBF}	N_{VH}	Composition of N_{bkg}: N_{WW} N_{WW}^{QCD}	N_{WW}^{EW}	N_{top} $N_{t\bar{t}}$	N_t	N_{misid} N_{Wj}	N_{jj}	N_{VV}	$N_{\mathrm{Drell\text{-}Yan}}$ $N_{ee/\mu\mu}$	$N_{\tau\tau}^{\mathrm{QCD}}$	$N_{\tau\tau}^{\mathrm{EW}}$
(b) Bins in O_{BDT}																
$e\mu$ sample																
Bin 0 (not used)	1.02 ± 0.04	661	650	8.8	3.0	1.9	83	9	313	40	26	21	28	2.2	126	1
Bin 1	0.99 ± 0.16	37	37	3.0	4.2	0.1	5.0	1.0	17	3.1	3.3	1.8	2.6	-	4.0	0.2
Bin 2	2.26 ± 0.63	14	6.2	1.2	4.2	-	1.5	0.5	1.8	0.3	0.4	0.3	0.8	-	0.3	0.3
Bin 3	5.41 ± 2.32	6	1.1	0.4	3.1	-	0.3	0.2	0.3	0.1	-	-	0.1	-	0.1	0.1

Procedure for ggF+2jets (S&T).

1) Look at the event yield at the BDT preselection:
all preselection cuts (except CJV) applied plus $O_{BDT} > -0.48$.

2) estimate $\delta\sigma_{\geq 2\_VBF}$ scale uncertainty (variation of events passing (1) with the usual renormalisation and factorisation scale variation: factor 2 between $m_H/4$ and m_H avoiding extremes $\mu_R = m_H/4 : \mu_F = m_H$, $\mu_R = m_H : \mu_F = m_H/4$;

3) estimate $\delta\sigma_{\geq 3\_VBF\text{-}CJV}$: events having a third jet, with $p_T > 20$ GeV, with rapidity inside the tagging VBF jets;

$$\sigma_{2j\,\mathrm{VBF-CJV}} = \sigma_{\geq 2\_\mathrm{VBF}} - \sigma_{\geq 3\_\mathrm{VBF-CJV}}$$

$$\delta^2\sigma_{2j\,\mathrm{VBF-CJV}} = \delta^2\sigma_{\geq 2\_\mathrm{VBF}} + \delta^2\sigma_{\geq 3\_\mathrm{VBF-CJV}}$$

At this point cancellation effect has been taken into account, use naive scale variation to evaluate the O_{BDT} shape uncertainties.

Uncertainties computed using ggF MCFM NLO ggF2jets.

ggF2jets in VBF 8 events respect to 76 events in the 2 jet bin: no need to preserve normalisation.

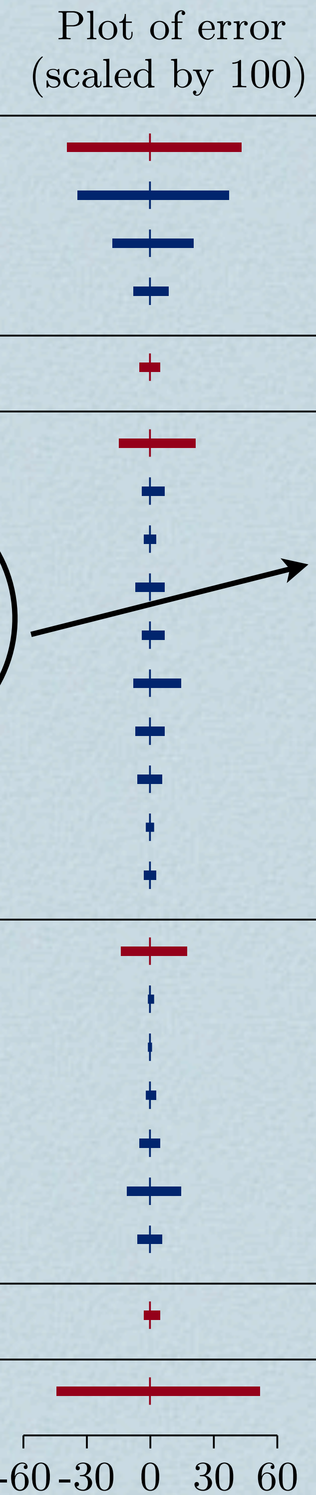
Uncertainty source	$n_j = 0$	$n_j = 1$	$n_j \geq 2$ ggF	$n_j \geq 2$ VBF
Gluon fusion				
Total cross section	10	10	10	7.2
Jet binning or veto	11	25	33	29
Acceptance				
Scale	1.4	1.9	3.6	48
PDF	3.2	2.8	2.2	-
Generator	2.5	1.4	4.5	-
UE/PS	6.4	2.1	1.7	15

BDT preselection (29)

O_{BDT} shape (48)

Impact on μ_{VBF}

Source	Observed $\mu_{VBF} = 1.27$ Error +	Error −
Data statistics	0.44	0.40
Signal regions	0.38	0.35
Profiled control regions	0.21	0.18
Profiled signal regions	0.09	0.08
MC statistics	0.05	0.05
Theoretical systematics	0.22	0.15
Signal $H \to WW^*$ $\mathcal{B}$	0.07	0.04
Signal ggF cross section	0.03	0.03
Signal ggF acceptance	0.07	0.07
Signal VBF cross section	0.07	0.04
Signal VBF acceptance	0.15	0.08
Background WW	0.07	0.07
Background top quark	0.06	0.06
Background misid. factor	0.02	0.02
Others	0.03	0.03
Experimental systematics	0.18	0.14
Background misid. factor	0.02	0.01
Bkg. $Z/\gamma^* \to ee$, $\mu\mu$	0.01	0.01
Muons and electrons	0.03	0.02
Missing transv. momentum	0.05	0.05
Jets	0.15	0.11
Others	0.06	0.06
Integrated luminosity	0.05	0.03
Total	0.53	0.45



ggF acceptance uncertainty impacts VBF at the same level of VBF cross section.

Could be interesting to reduce such ucertainty on the long run, when high data statistics will be available.

Run-II: JVE extension to ggF bkg in VBF.

(More aestethic than substantial with the first data statistics.)

available in GoSam [Phys. Lett. B721 (2013)]

$$\epsilon_2^{(a)} = 1 - \frac{\sigma_{\geq 3}^{\rm NLO}}{\sigma_{\geq 2}^{\rm NNLO}} \qquad \epsilon_2^{(b)} = 1 - \frac{\sigma_{\geq 3}^{\rm NLO}}{\sigma_{\geq 2}^{\rm NLO}}$$

available

not available

$$\epsilon_2^{(c)} = 1 - \frac{\sigma_{\geq 3}^{\rm NLO}}{\sigma_{\geq 2}^{\rm LO}} + \left(\frac{\sigma_{\geq 2}^{\rm NLO}}{\sigma_{\geq 2}^{\rm LO}} - 1 \right) \frac{\sigma_{\geq 3}^{\rm LO}}{\sigma_{\geq 2}^{\rm LO}}$$

Most likely $\sigma_{\geq 2}$ @NNLO will not be available, we could try the present approach used for 1 jet, using only schemes b) and c).

Run-II: full resummed JVE in 1 jet?

(More aestethic than substantial with the first data statistics.)

$$\epsilon_1^{(a)} = 1 - \frac{\sigma^{\mathrm{NLO}}_{\geq 2}}{\sigma^{\mathrm{NNLO}}_{\geq 1}}$$

Missing element.

Not available, but part of the NNNLO calculation on σ_{tot} that is absolutely needed.

	Observed $\mu = 1.09$			Observed $\mu_{ggF} = 1.02$		
Source	Error +	Error −	Plot of error (scaled by 100)	Error +	Error −	Plot of error (scaled by 100)
Theoretical systematics	0.15	0.12		0.19	0.16	
Signal $H \to WW^*$ $\mathcal{B}$	0.05	0.04		0.05	0.03	
Signal ggF cross section	0.09	0.07		0.13	0.09	
Signal ggF acceptance	0.05	0.04		0.06	0.05	

Prelminary estimates: Petriello, arXiv:1302.6216 [gg only, 1 jet NNLO]

Run-II: going beyond S&T and JVE.

From the correlation point of view:

S&T: uncertainties on $\sigma_{\geq N}$ are uncorrelated.
JVE: uncertainties on $\sigma_{\geq 0}$, ε_0 and ε_1 are uncorrelated.

Both of them are reasonable and unjustified at the same time.
Attempt to attack the correlation problem (R. Boughezal et al., arXiv:1312.4535)

$$C_{\mathrm{y}}(\{\sigma_0, \sigma_1, \sigma_{\geq 2}\}) = \begin{pmatrix} (\Delta_0^{\mathrm{y}})^2 & \Delta_0^{\mathrm{y}}\Delta_1^{\mathrm{y}} & \Delta_0^{\mathrm{y}}\Delta_{\geq 2}^{\mathrm{y}} \\ \Delta_0^{\mathrm{y}}\Delta_1^{\mathrm{y}} & (\Delta_1^{\mathrm{y}})^2 & \Delta_1^{\mathrm{y}}\Delta_{\geq 2}^{\mathrm{y}} \\ \Delta_0^{\mathrm{y}}\Delta_{\geq 2}^{\mathrm{y}} & \Delta_1^{\mathrm{y}}\Delta_{\geq 2}^{\mathrm{y}} & (\Delta_{\geq 2}^{\mathrm{y}})^2 \end{pmatrix}$$

yield uncertainties, uncorrelated.

$$C_{\mathrm{cut}}(\{\sigma_0, \sigma_1, \sigma_{\geq 2}\}) = \begin{pmatrix} \Delta_{0\,\mathrm{cut}}^2 & -\Delta_{0\,\mathrm{cut}}^2 + C_{01\,\mathrm{cut}} & -C_{01\,\mathrm{cut}} \\ -\Delta_{0\,\mathrm{cut}}^2 + C_{01\,\mathrm{cut}} & \Delta_{0\,\mathrm{cut}}^2 + \Delta_{1\,\mathrm{cut}}^2 - 2C_{01\,\mathrm{cut}} & -\Delta_{1\,\mathrm{cut}}^2 + C_{01\,\mathrm{cut}} \\ -C_{01\,\mathrm{cut}} & -\Delta_{1\,\mathrm{cut}}^2 + C_{01\,\mathrm{cut}} & \Delta_{1\,\mathrm{cut}}^2 \end{pmatrix}$$

$N \rightarrow N+1$ migrations
they sum up to zero in the total cross section.

1 jet resummation.

Together with the 1 jet bin resummation could become the basis for Run-II.

Problem of resummation in 1 jet:

3 scales problem: p_T^{cut}, p_T^J, m_H
resummation works typically with 2 scales:
can resum only one $\log(p_T/m_H)$.

Resummation performed in the $p_T^j > m_H$ case
[X. Liu, F. Petriello, Phys. Rev. D87, 094027 (2013)]

Partial resummation available in 1312.4535
Need to come to an agreement on the usability of such results in the next year.

i	*JVE*	*1312.4535*
0	14%	10%
1	25%	16%
≥2	39%	17%

The gain is numerically important. Need to follow up in next months.

Using just MC?

ATLAS (going to be made public)

Table 3: Uncertainties in percent due to different scale choices evaluated for different cut scenarios with the POWHEG NNLOPS samples. The uncertainties include normalization and shape effects.

Scale Variation	no cut	0 jets	≥ 1 jet	1 jet	≥ 2 jets	$p_T(H) < 20$ GeV	$p_T(H) > 100$ GeV
μ(NNLO)							
$0.5 \cdot m_H$	10%	12%	8%	9%	6%	12%	4%
$2 \cdot m_H$	-10%	-11%	-7%	-7%	-4%	-12%	-4%
μ(MINLO)							
$0.5 \cdot \mu_{def.}$(MINLO)	~0.0%	-4%	8%	7%	12%	-3%	18%
$2 \cdot \mu_{def.}$(MINLO)	~0.0%	4%	-8%	-6%	-12%	6%	16%

i	JVE	1312.4535
0	14%	10%
1	25%	16%
≥2	39%	17%

Using MINLO (with quadratic sum) could give uncertinties of the same size of the new resummed approach.

Confirmation that this is the good direction? Need to check with uncorrelated μ_R, μ_F scale variations.

Conclusions.

- Jet acceptance uncertainty quite sub-dominant, at this point, both in ggF and VBF channels using the most recent developments;

- Jet-bin uncertainties can become relevant if the total cross section uncertainties will be reduced (both scale using NNNLO and PDFs);

- At the end of Run-II we could have enough statistics for which it would be needed to reduce the present level of uncertainties, need to work in the next year through the new proposal on resummation and the use of 3j NLO, now available calculations.