Simulation of $W\gamma$ and $Z\gamma$ Production at CMS using the CMSJET Detector Parametrization

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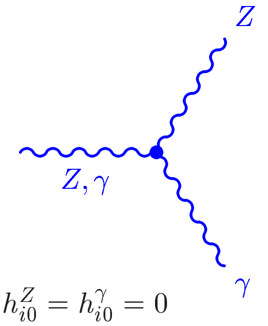
- Non–standard $ZZ\gamma$ and $Z\gamma\gamma$ couplings

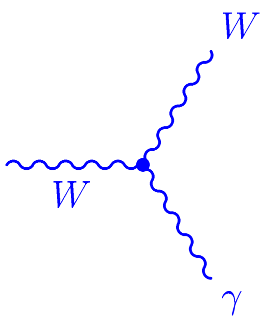
$\rightsquigarrow$ additional diagrams



(SM forbidden) + NLO

SM: $h^Z_{i0} = h^\gamma_{i0} = 0$ $(i = 1, 2, 3, 4)$

- Non–standard $WW\gamma$ couplings



+ NLO

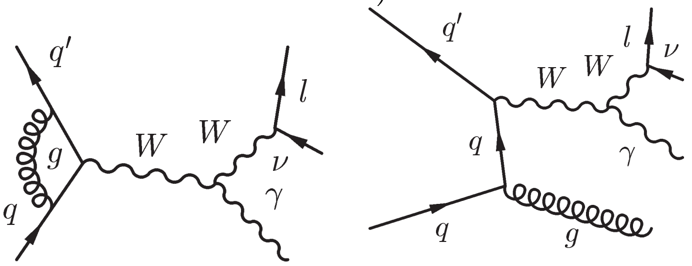
SM: $\kappa = 1$
$\lambda = \tilde{\kappa} = \tilde{\lambda} = 0$

excess of high p^T events through missing gauge cancellation

Event Generation:

BAUR/OHNEMUS $W\gamma$ and $Z\gamma$ NLO generators
(Interface to detector simulation added)

NLO (QCD):



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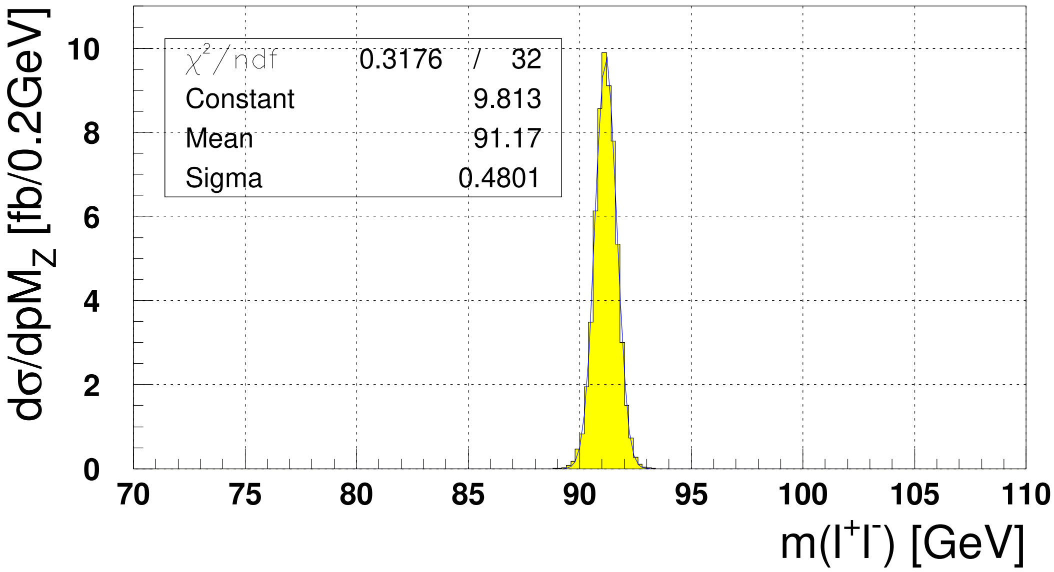
Detector Simulation:

CMSJET 4.3 ($W\gamma$)
CMSJET 4.6 ($Z\gamma$)

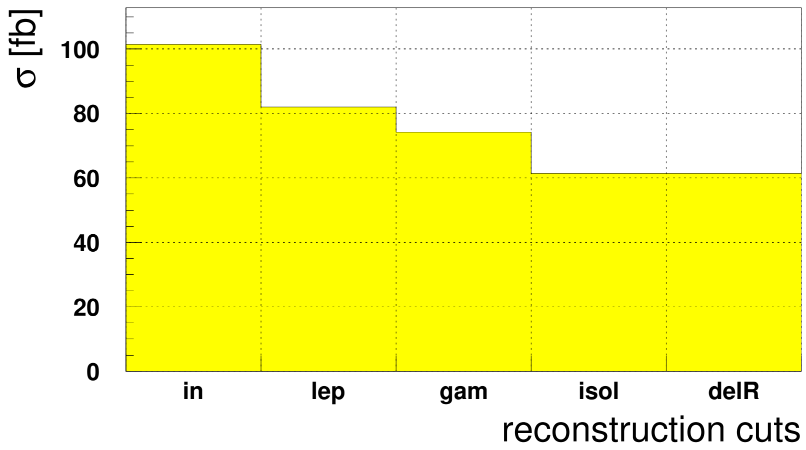
$$pp \to Z\gamma + X \to l^+l^-\gamma + X, \qquad l = e, \mu$$



Cuts:

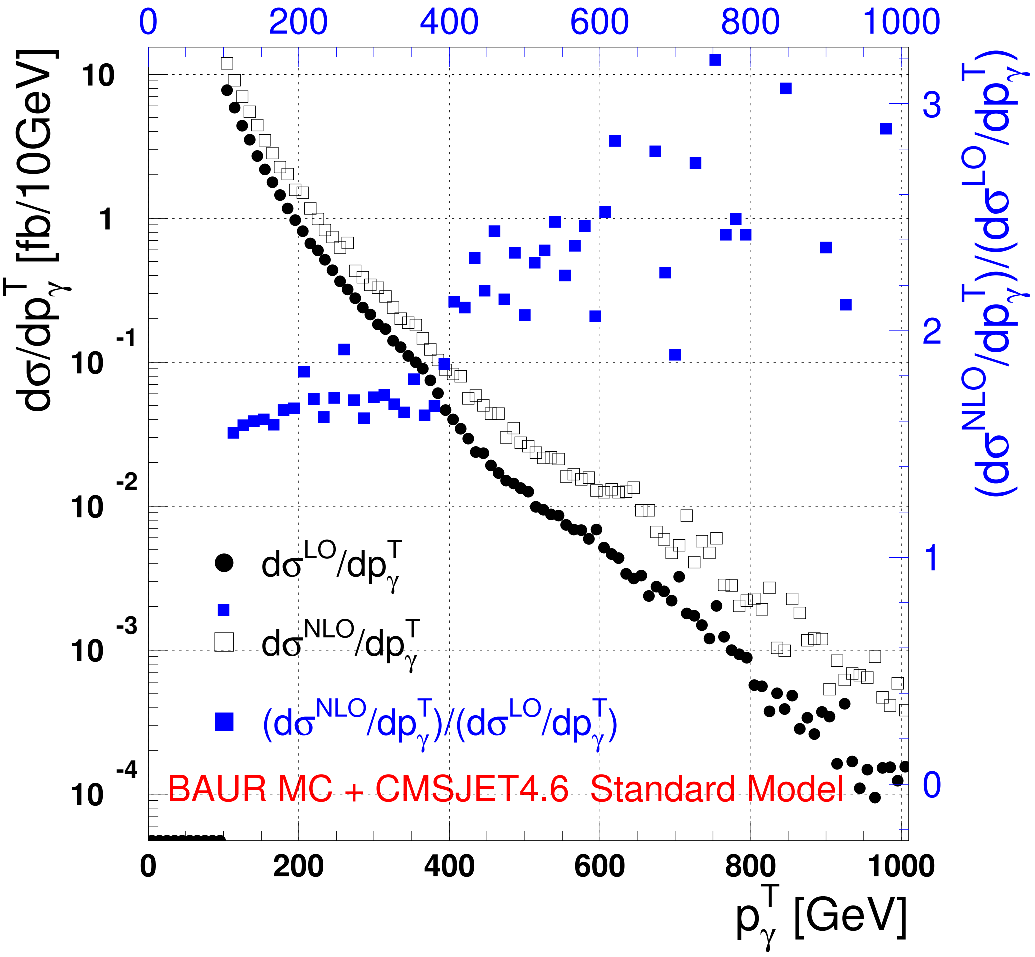
$W\gamma$	$Z\gamma$
$p_\gamma^T > 50\,\mathrm{GeV}$	$p_\gamma^T > 100\,\mathrm{GeV}$
$p_l^T > 25\,\mathrm{GeV}$	$p_l^T > 20\,\mathrm{GeV}$
$\not{p}^T > 50\,\mathrm{GeV}$	
$p_{\mathrm{jet}}^T > 50\,\mathrm{GeV}$	
$\lvert\eta_\gamma\rvert < 2.5$	$\lvert\eta_\gamma\rvert < 3$
$\lvert\eta_l\rvert < 3$	$\lvert\eta_l\rvert < 3$
$\lvert\eta_{\mathrm{jet}}\rvert < 3$	
$M^T(l\gamma; \not{p}^T) > 90\,\mathrm{GeV}$	$M(ll\gamma) > 100\,\mathrm{GeV}$
	$\sum_{\Delta R_{l,\gamma}<0.7} E_{\mathrm{had}} < 0.15 E_\gamma$
$\Delta R_{l,\gamma} > 0.7$	

$$pp \to Z\gamma + X \to l^+l^-\gamma + X, \qquad l = e, \mu$$



Why NLO?

$$pp \to Z\gamma + X \to l^+l^-\gamma + X, \qquad l = e, \mu$$



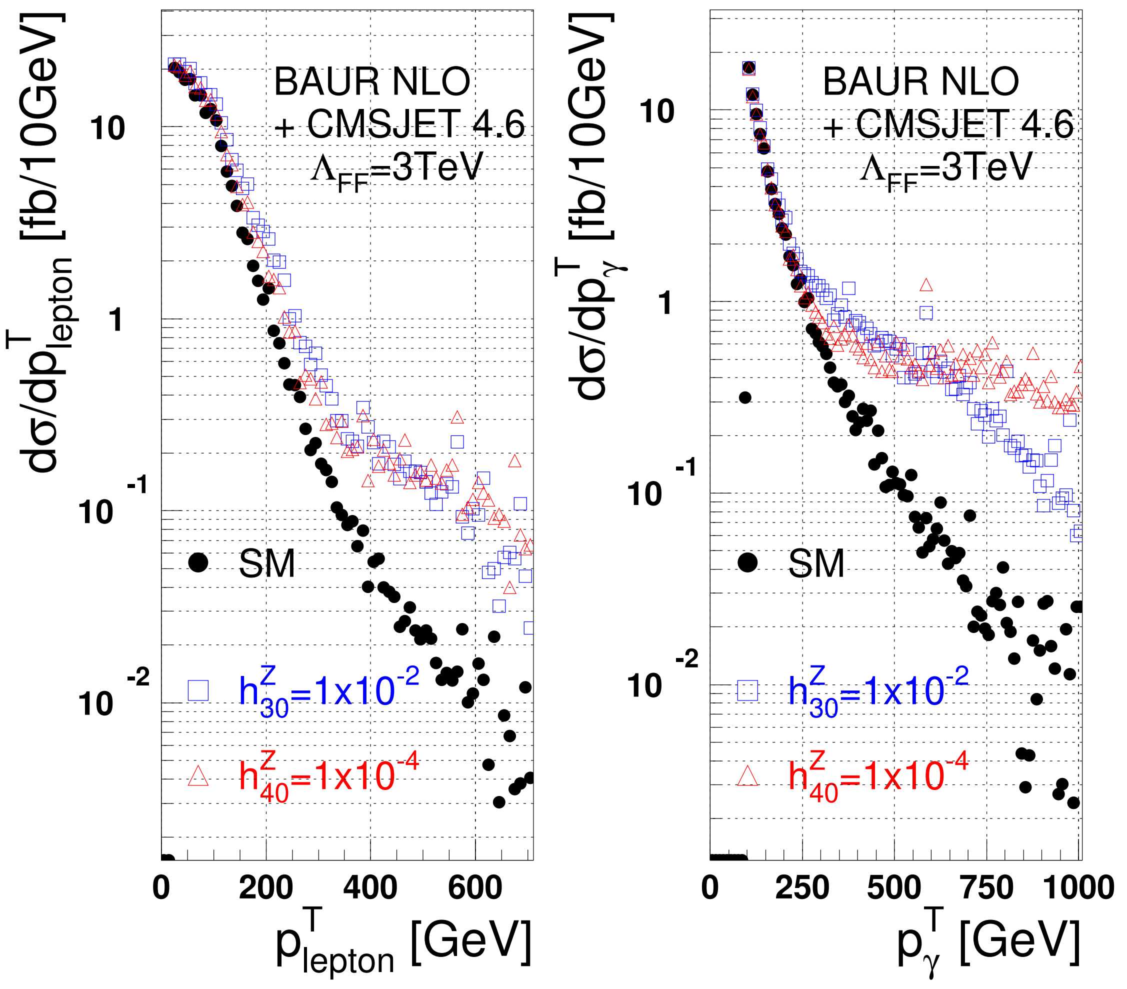
Significant NLO contributions at LHC energy

$$\frac{\mathrm{d}\sigma^{\mathrm{NLO}}/\mathrm{d}p_\gamma^T}{\mathrm{d}\sigma^{\mathrm{LO}}/\mathrm{d}p_\gamma^T} \gtrsim 1.5 \quad (\, p_\gamma^T > 100\,\mathrm{GeV}\,)$$

PRELIMINARY

Anomalous couplings

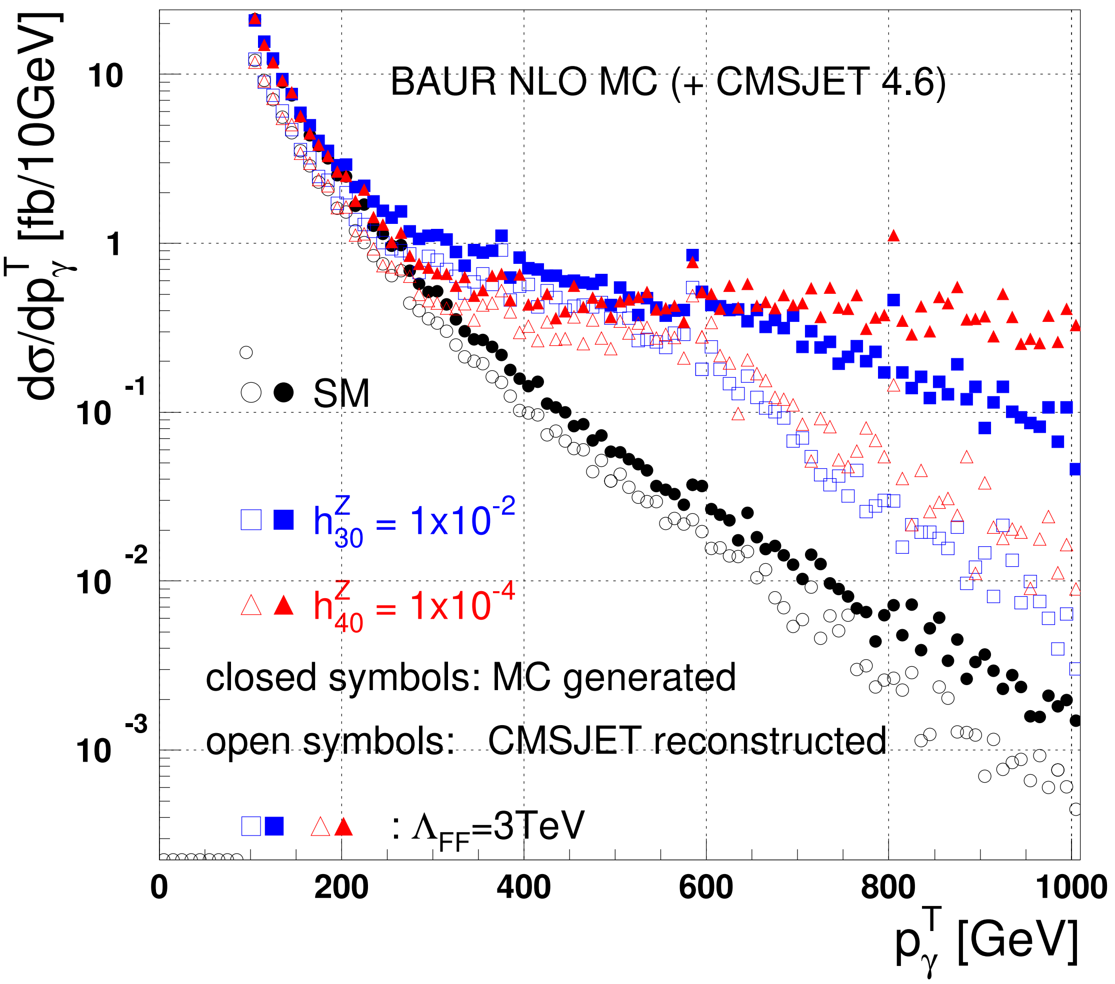
$$pp \to Z\gamma + X \to l^+l^-\gamma + X, \qquad l = e, \mu$$



PRELIMINARY

CMSJET reconstruction

$$pp \to Z\gamma + X \to l^+l^-\gamma + X, \qquad l = e, \mu$$



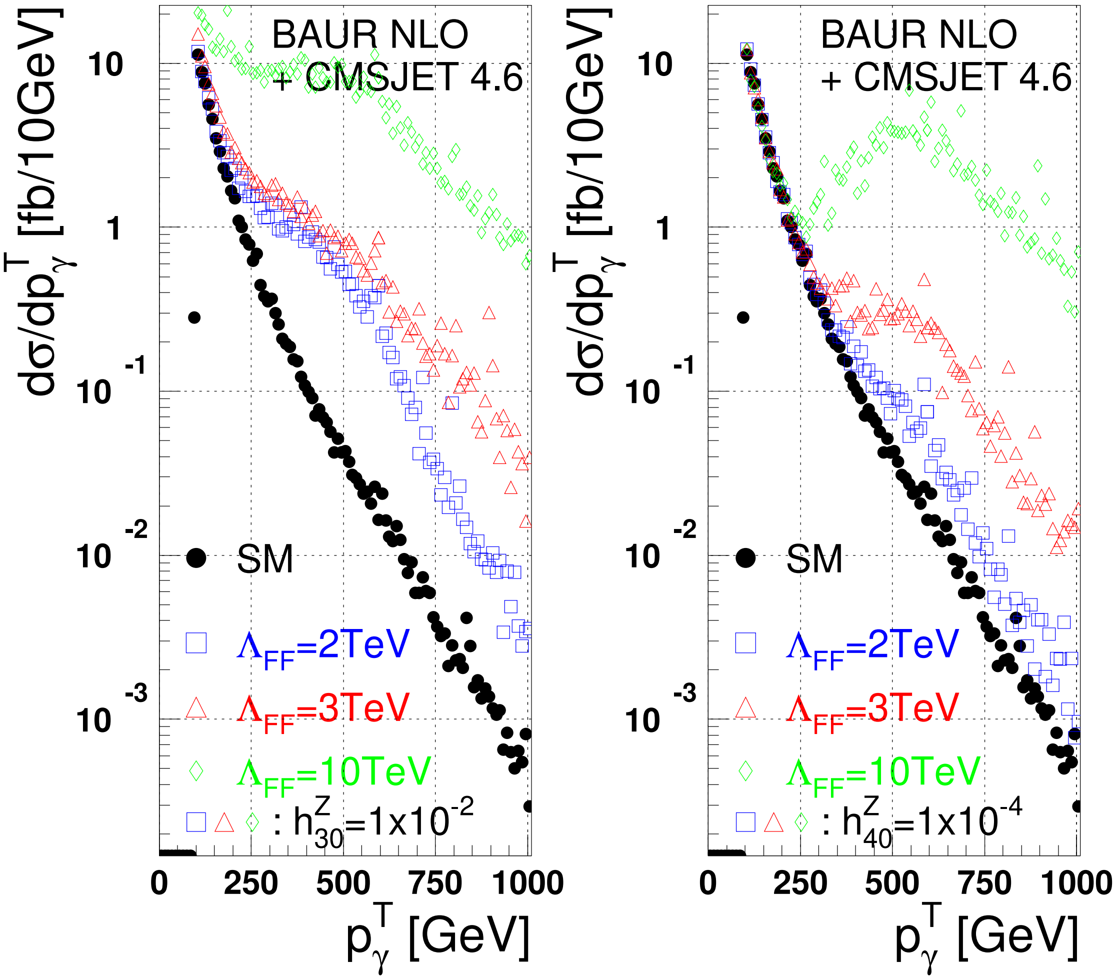
High–p^T events are suppressed by the reconstruction
(assumed to be effect of photon isolation cut — is being studied)

PRELIMINARY

Formfactor scale Λ_{FF}

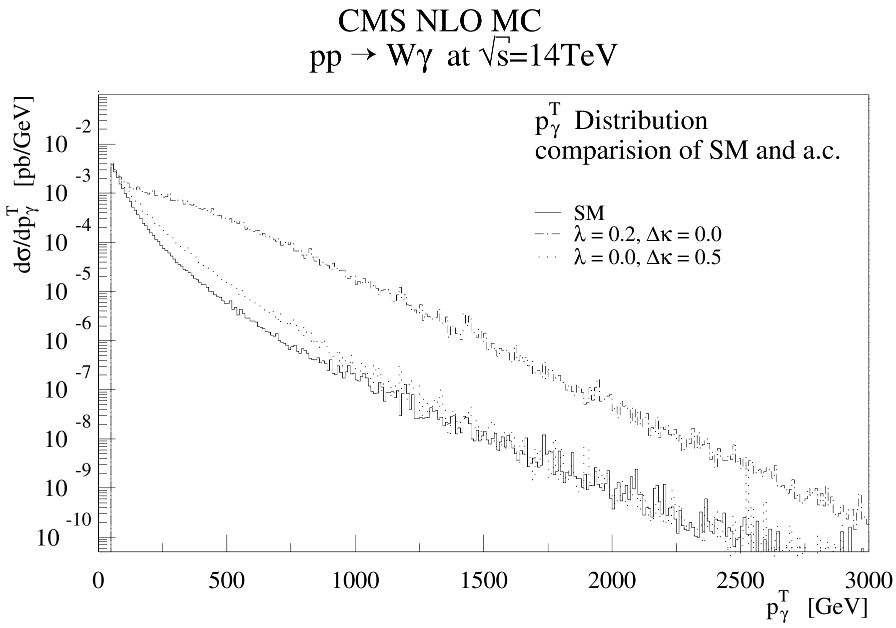
(to preserve tree–level unitarity)

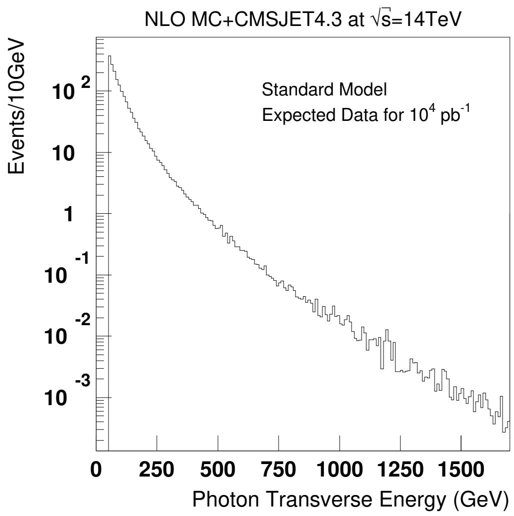
$$pp \to Z\gamma + X \to l^+l^-\gamma + X, \qquad l = e, \mu$$

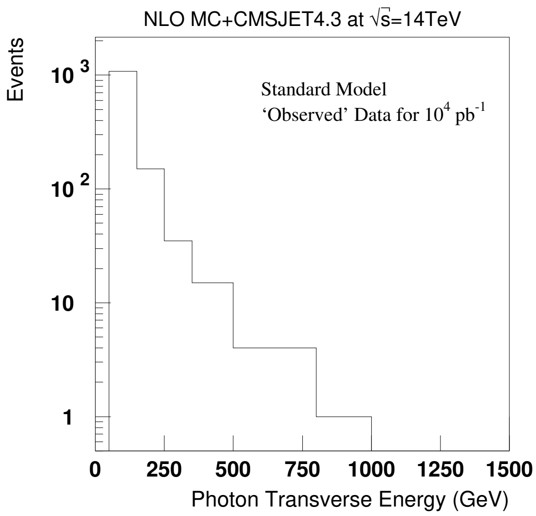


choice of Λ_{FF} has significant impact on p^T–distributions

$W\gamma$

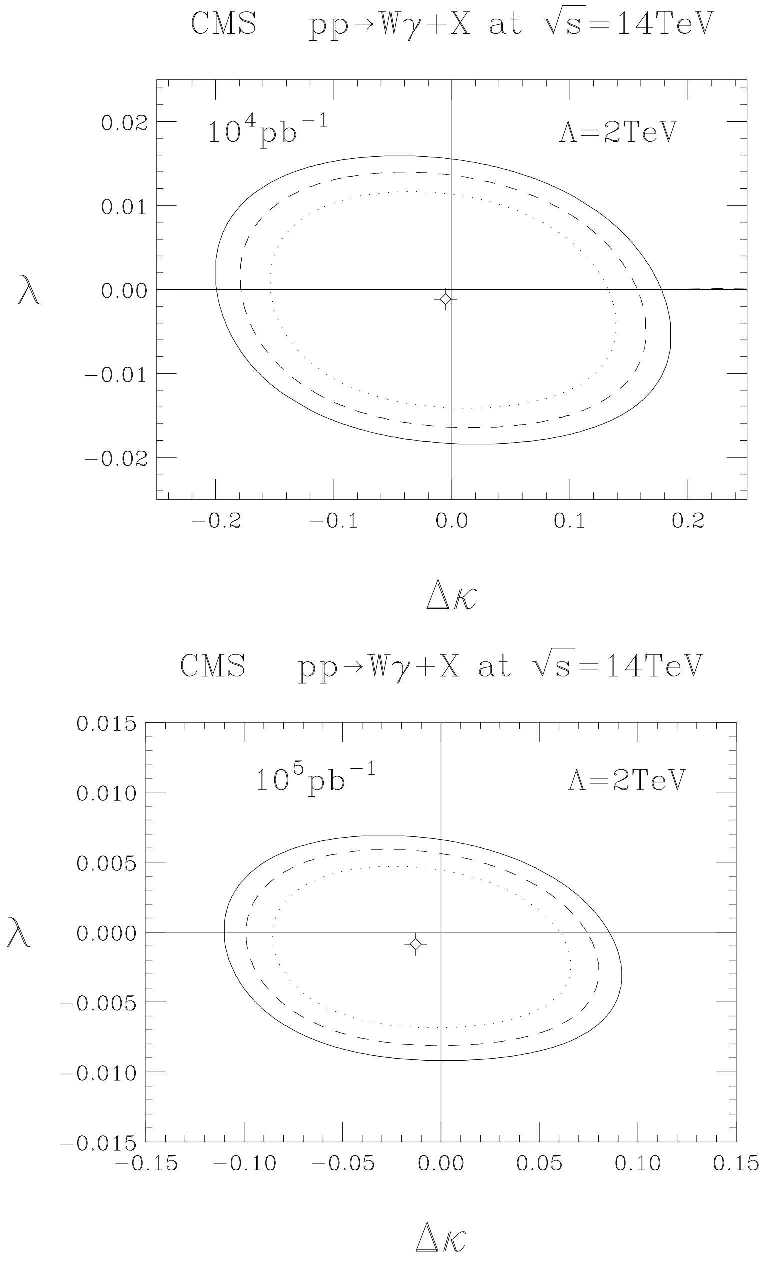






Sensitivities are derived with a binned likelihood method

Limit contours for $W\gamma$



Conclusions:

$W\gamma$

$$|\Delta\kappa| \lesssim 0.1$$

$$|\lambda| \lesssim 0.01$$

($\Lambda_{\mathrm{FF}} = 2\,\mathrm{TeV}$, using CMSJET 4.3)

$Z\gamma$

- strong impact of Λ_{FF} seen
- effect of reconstruction on p^T–distributions seen

Outlook:

$W\gamma$

- redo analysis with CmsJet 4.6
- study background effects (fake W, W + jet)
- unbinned likelihood

$Z\gamma$

- derive sensitivity contours to anomalous couplings
- background studies (fake $Z\gamma$ from Z + jet)