

Colored SUSY particle production at the LHC

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WORK IN COLLABORATION WITH
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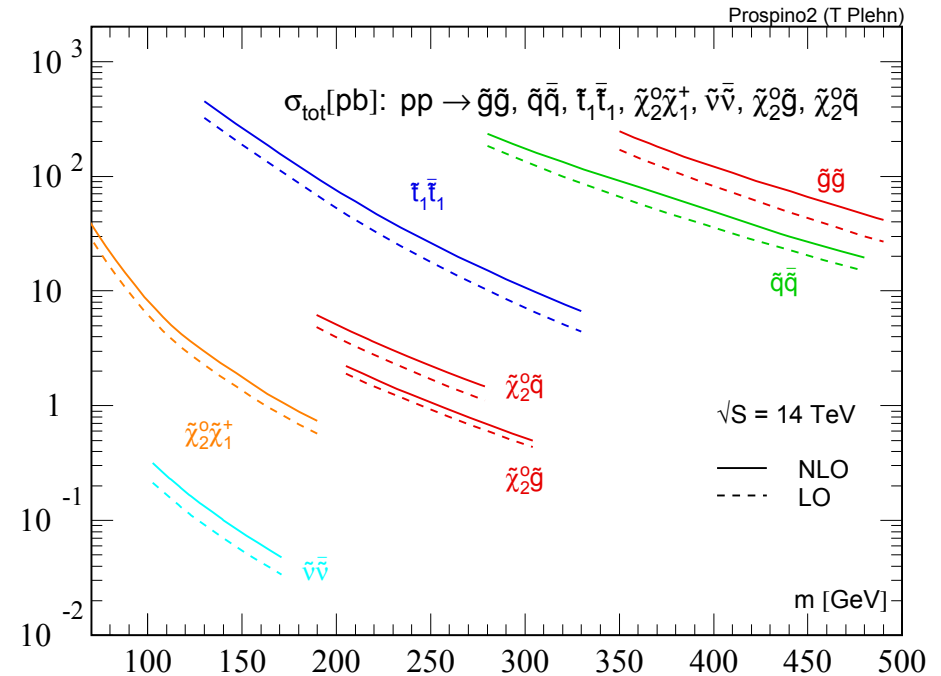
LHC: predominantly colored SUSY particles produced

- pair production of gluinos and squarks proceeds via **strong interaction**

→ **large cross sections**

- large top-Yukawa coupling: **top-squark \tilde{t}_1** candidate for **lightest squark**

→ **high production rate**

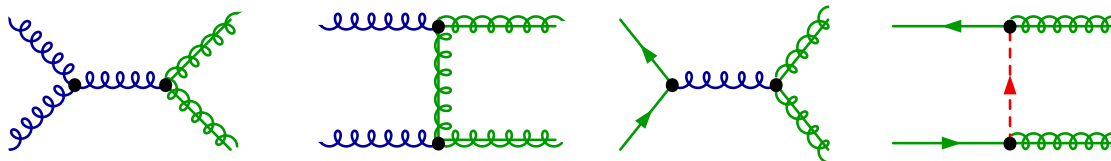


- **cross section depend** essentially **on final state masses**

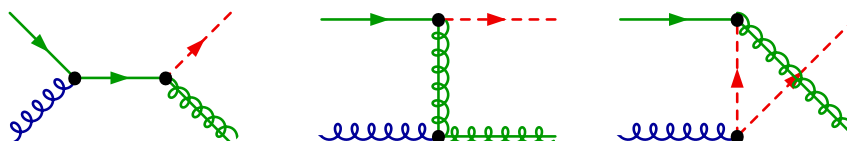
LO contributions to squark pair production (QCD tree level)

*Kane, Leveille '82; Harrison, Llewellyn Smith '83; Reya, Roy '85;
Dawson, Eichten Quigg '85, Baer, Tata '85*

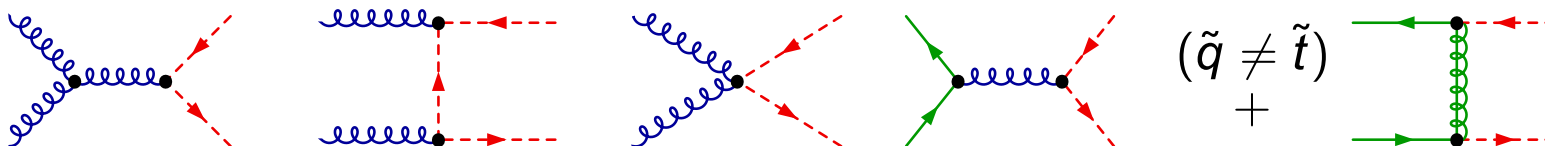
- $\mathcal{O}(\alpha_s^2)$: – $\tilde{g}\tilde{g}$ production



- $\tilde{g}\tilde{q}$ production



- $\tilde{q}\tilde{q}^*$, $\tilde{b}_i\tilde{b}_i^*$, $\tilde{t}_i\tilde{t}_i^*$ production; $\tilde{q}\tilde{q}$ production

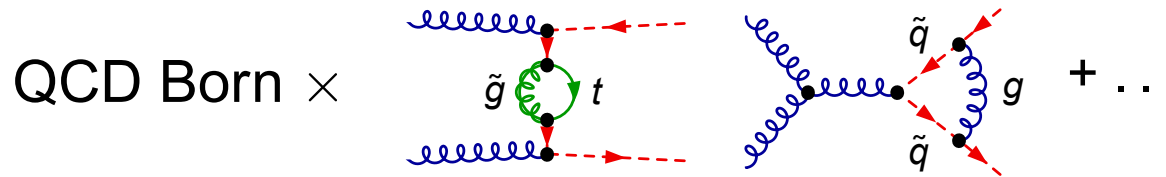


Important **higher order effects** due to **QCD corrections**:

[Beenakker, Höpker, Spira, Zerwas '95 & '97] &
 [Beenakker, Krämer, Plehn, Spira, Zerwas '98]

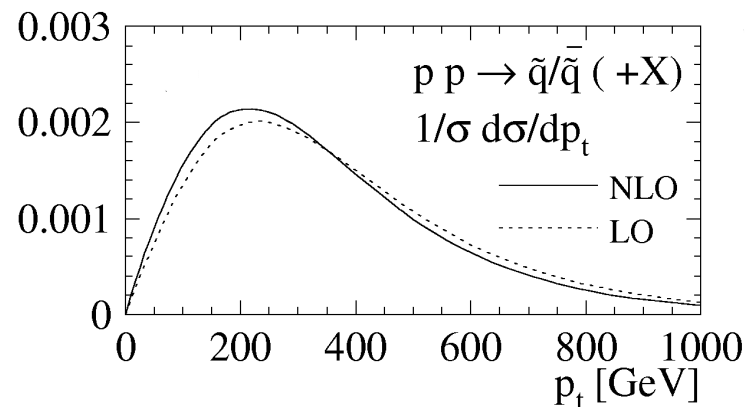
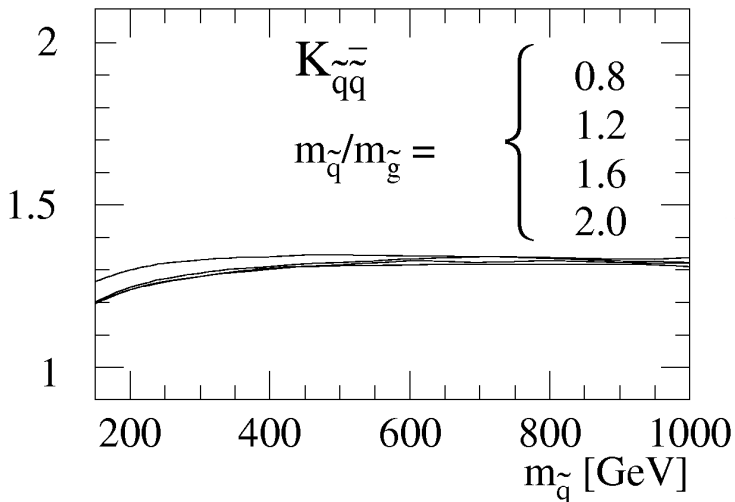
→ PROSPINO, also for $\tilde{g}\tilde{q}, \tilde{g}\tilde{g}$

- $\mathcal{O}(\alpha_s^3)$: QCD NLO corrections



+ real gluon & real quark radiation

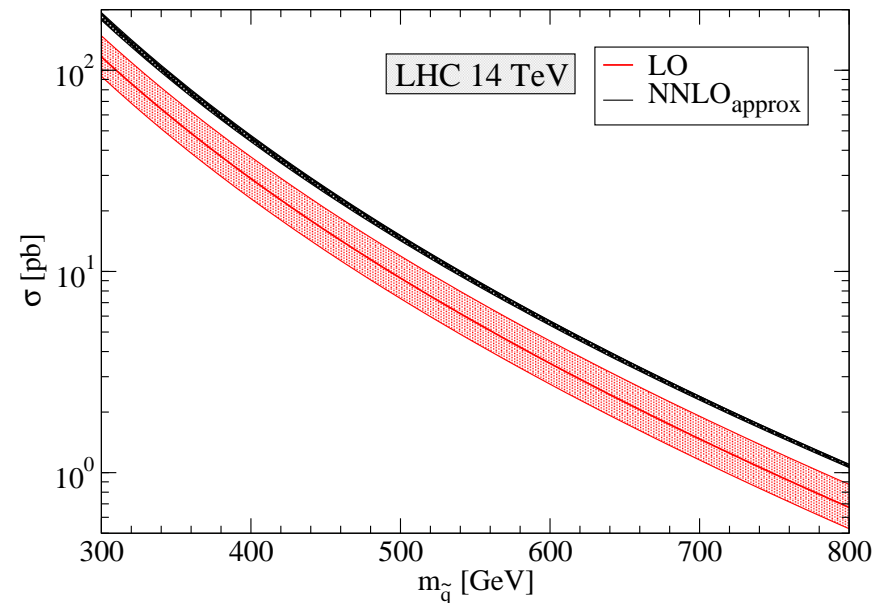
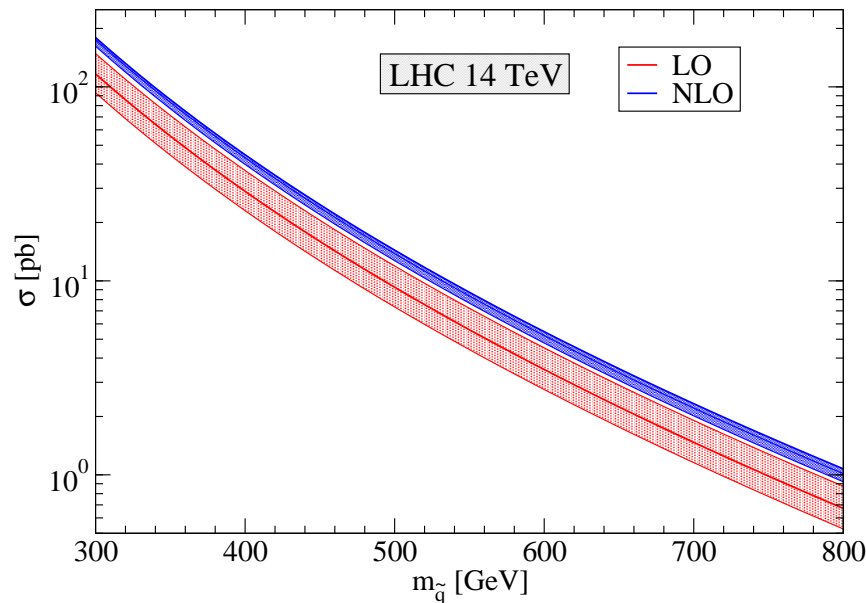
$[\tilde{q}\tilde{q}^* \text{ production:}]$



- large positive corrections
- reduced scale dependence
- negligible in normalized distributions

NNLO for squark production, dominant soft corrections

Kulesza, Motyka 2008/9; Langenfeld, Moch 2009



- improved theoretical prediction
- reduction of scale uncertainty

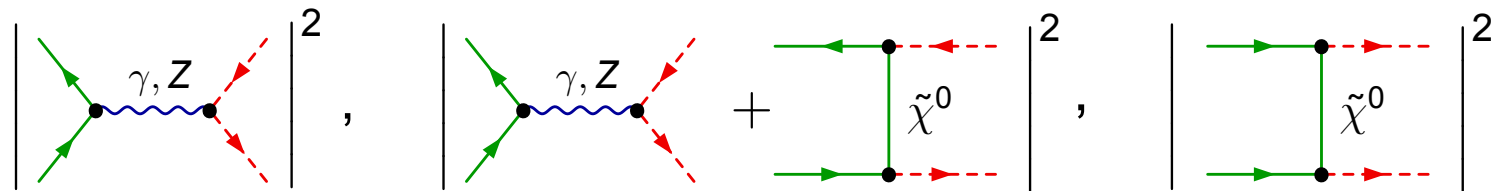
NNLO QCD contributions \sim electroweak contributions

EW tree level contributions to squark pair production

Bornhauser, Drees, Dreiner, Kim 2007

Bozzi, Fuks, Herrmann, Klasen 2007

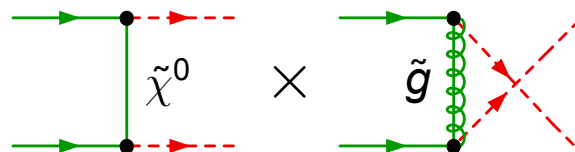
- $\mathcal{O}(\alpha^2)$: pure EW tree-level contributions ($\tilde{t}\tilde{t}^*$, $\tilde{q}\tilde{q}^*$, $\tilde{q}\tilde{q}$ prod.)



- $\mathcal{O}(\alpha_s \alpha)$: – EW-QCD tree-level interferences to $\tilde{q}\tilde{q}^*$ production



- EW-QCD tree-level interferences to $\tilde{q}\tilde{q}$ production

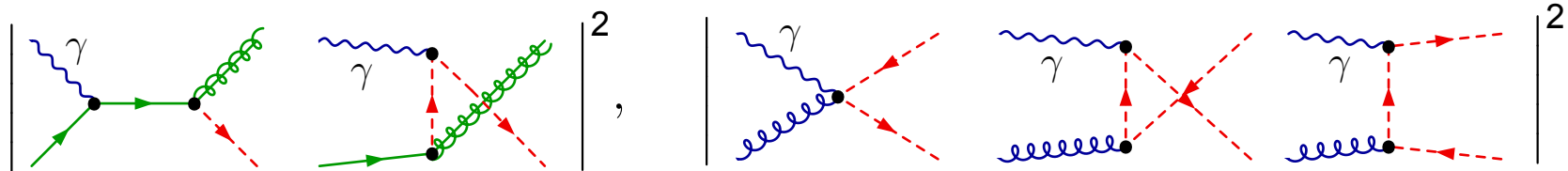


new production channel:

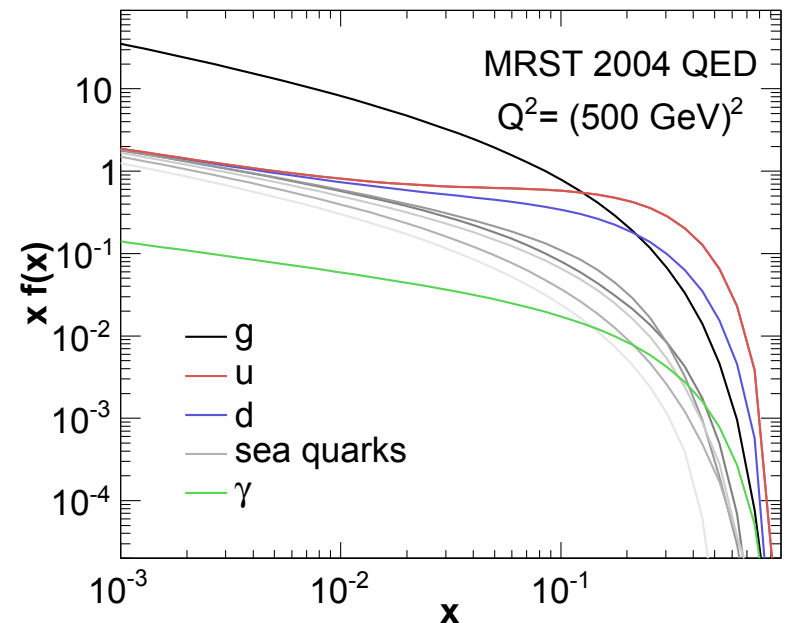
WH, Kollar, Trenkel 2007

WH, Mirabella 2008

- $\mathcal{O}(\alpha_s\alpha)$: photon induced processes

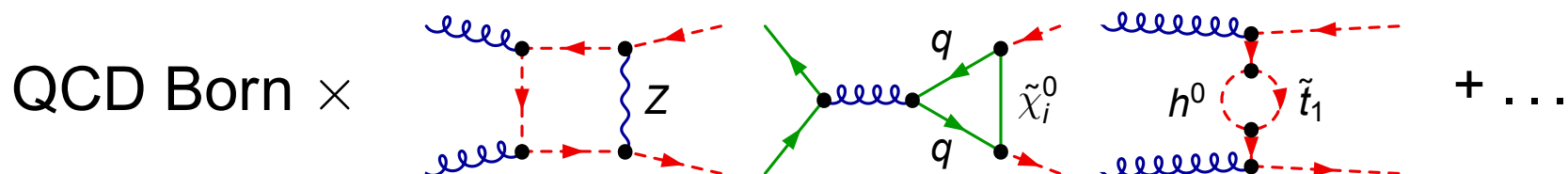


- not present at LO at the hadronic level
- **MRST 2004 QED**: inclusion of **NLO QED effects** in the evolution of PDFs
 - non-zero photon distribution
 - non-zero hadronic contributions

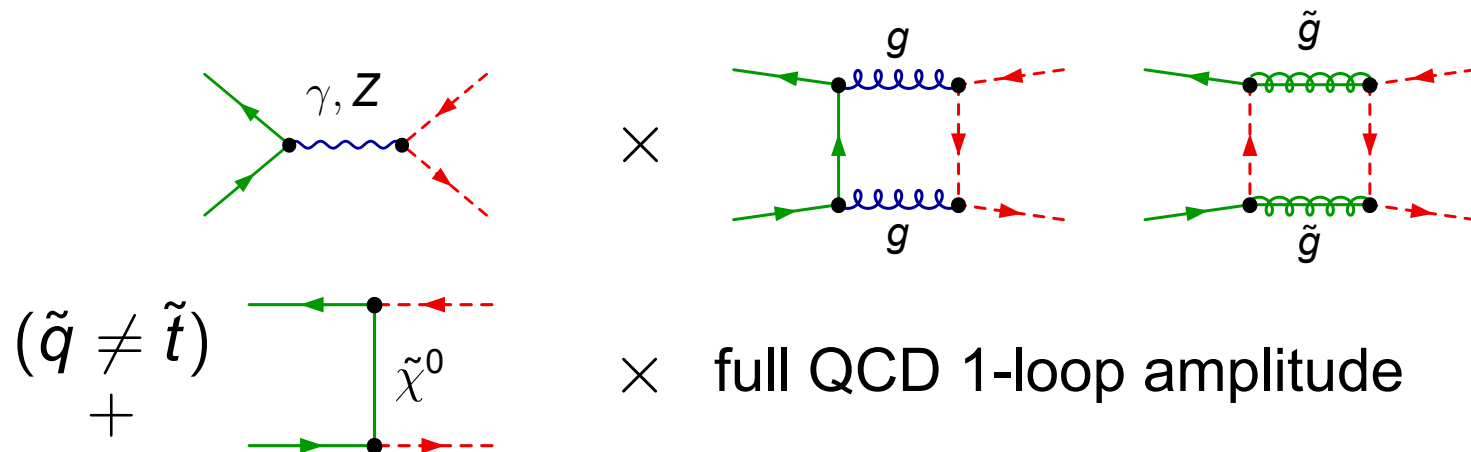


• $\mathcal{O}(\alpha_s^2 \alpha)$: NLO EW contributions

WH, Kollar, Mirabella, Trenkel 07,08



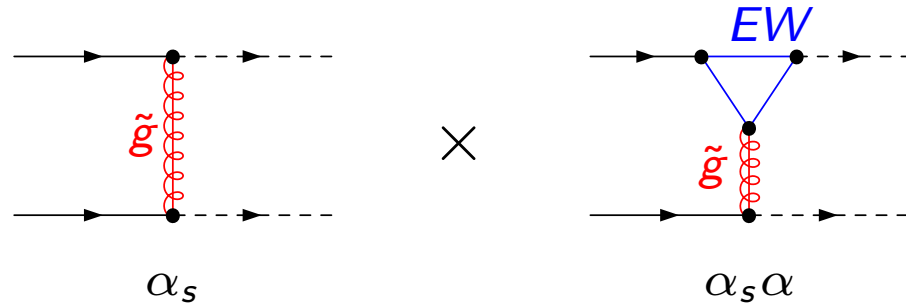
+ EW-QCD one-loop interferences



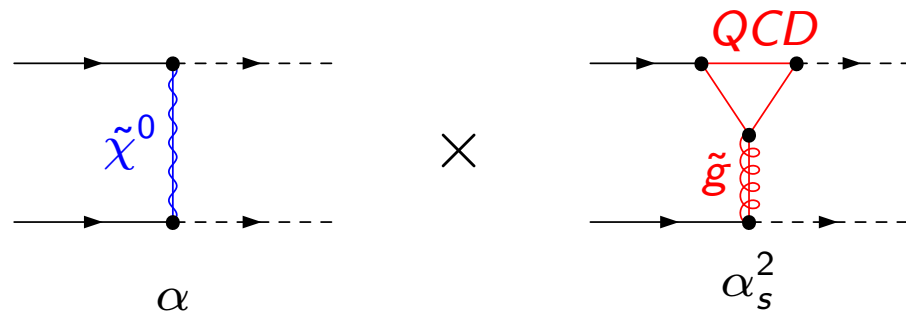
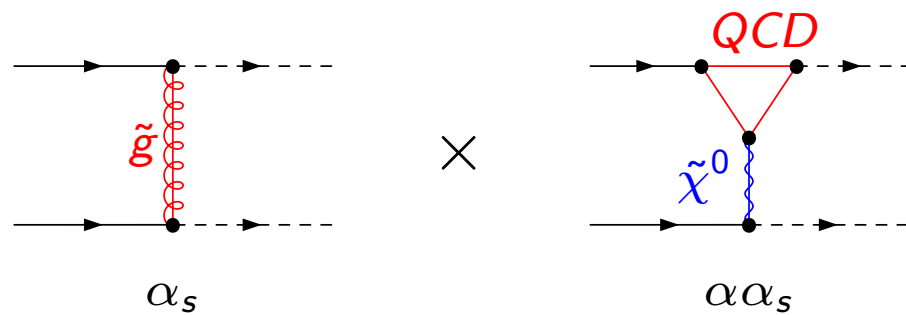
+ real photon, gluon, and quark radiation

virtual NLO contributions $\mathcal{O}(\alpha_s^2 \alpha)$

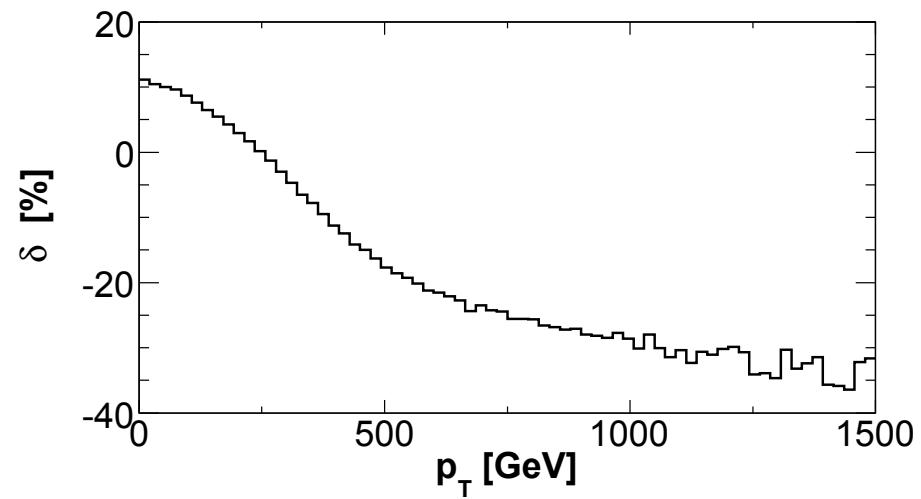
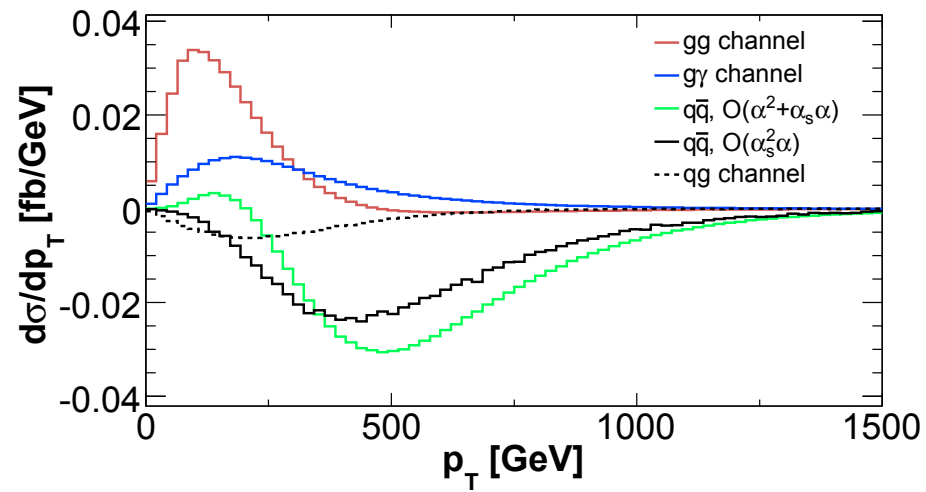
EW insertions:



QCD insertions:

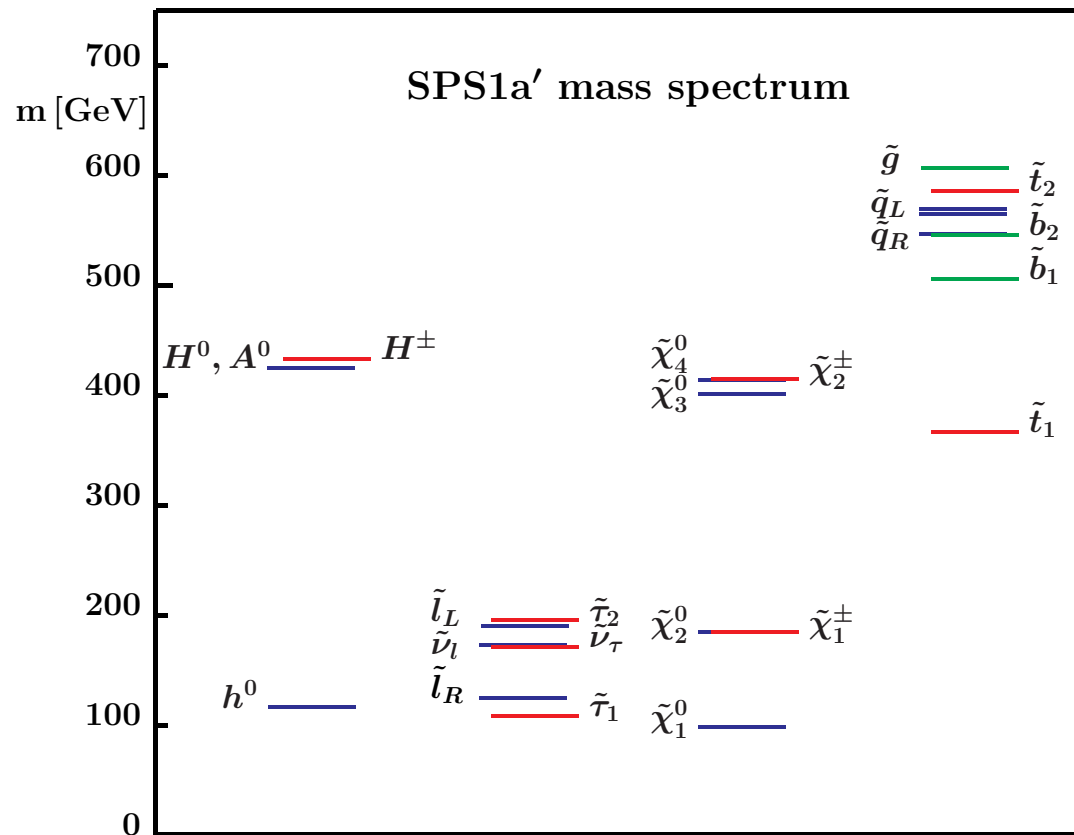


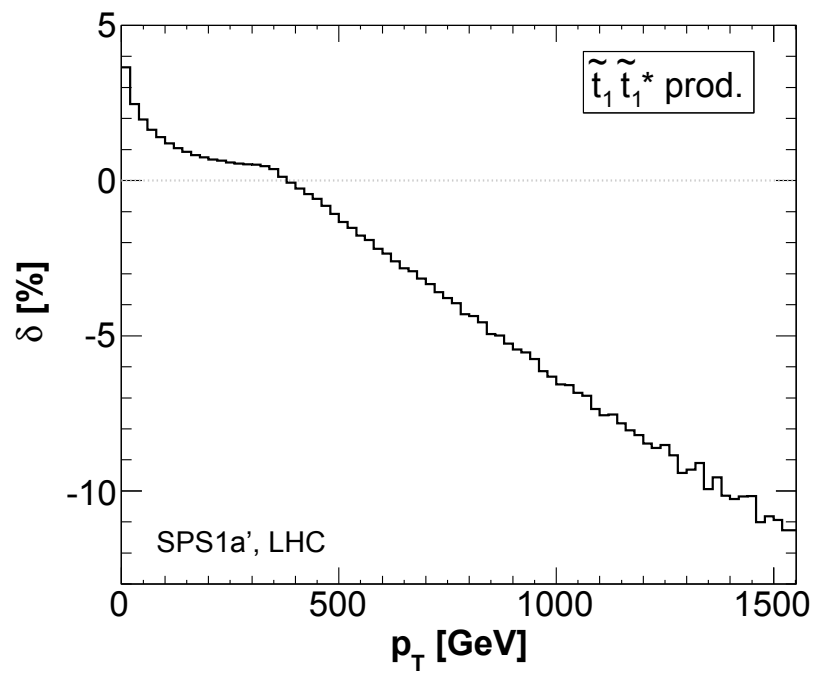
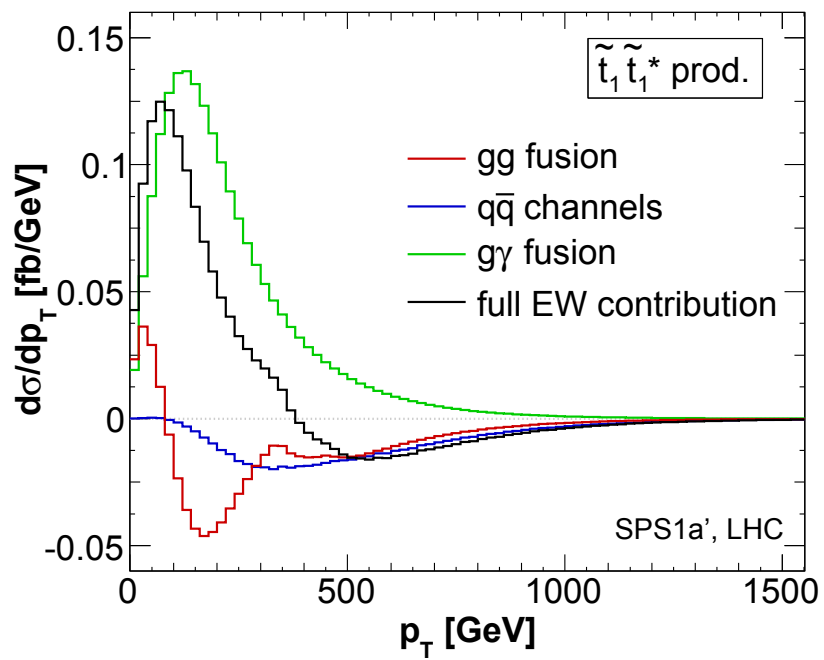
$u_L u_L^*$, $SPS1a'$



SPS1a' scenario [SPA Report, hep-ph/0511344]

$M_{1/2}$	=	250 GeV	$\text{sign}(\mu)$	=	+1
M_0	=	70 GeV	$\tan \beta(\tilde{M})$	=	10
A_0	=	-300 GeV			





xsections in fb, SPS1a'

scenario	(sub-) process	LO $\mathcal{O}(\alpha_s^2)$	EW contr. per channel			EW contr. δ
			$\mathcal{O}(\alpha_s^2\alpha)$	$\mathcal{O}(\alpha_s\alpha)$	$\mathcal{O}(\alpha^2)$	
SPS1a'	gg	153	-24.9			-16.3%
	$q\bar{q}$	33.1	-6.65		0.32	-19.1%
	γg			3.78		
	gq		$< 10^{-3}$			
	incl. $\tilde{t}_2\tilde{t}_2^*$	186	-31.6	3.78	0.32	-14.8%

Subprocess	Electroweak contribution	Strong contribution
$qq \rightarrow \tilde{q}_a \tilde{q}_b$		
$qq' \rightarrow \tilde{q}_a \tilde{q}'_b$ same doublet		
$qq' \rightarrow \tilde{q}_a \tilde{q}'_b$ different doublet		

$NLO \mathcal{O}(\alpha_s^2 \alpha)$ ongoing work