

# Next-to-leading order SUSY pair productions in MadNLO/GOLEM

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# In the era of the LHC

- At the LHC (and the future ILC), heavy new particles are expected to be copiously produced.
- Monte Carlo (MC) event generators are indispensable to simulate those scattering processes.
- At present, MC event generators are mostly based on **tree level** matrix elements (ME), combining with parton shower (PS) and hadronization model.
- Recently, the ME/PS matching schemes have been developed.

# Beyond LO MC event generators

- One missing piece is a prediction of **absolute rates**, which require higher order calculations because leading-order (LO) predictions are spoiled by uncertainties of the renormalization and factorization scales.
- There are several tools to calculate the next-to-leading order (NLO) cross sections, but those calculations are mostly process-dependent.
- Our main goal is **the fully automatized NLO (SUSY)-QCD computations for SUSY pair productions**.

# MadNLO/GOLEM

- \* Catani-Seymour dipole subtraction method (to remove IR divergences)
- \* Feynman-diagram-based method with spinor helicity formalism (to evaluate one-loop amplitude)

$$\begin{aligned}\sigma &= \int_m d\sigma^B + \int_{m+1} [d\sigma^R - d\sigma^A] + \int_m \left[ \int_1 d\sigma^A + d\sigma^V \right] \\ &= \sigma^B + \bar{\sigma}^R + \bar{\sigma}^V\end{aligned}$$

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 \text{MadGraph} \qquad \qquad \qquad \text{(modified) MadDipole} \qquad \qquad \text{Qgraf+MadGolem} \\
 \swarrow \qquad \searrow \qquad \qquad \swarrow \qquad \searrow \qquad \qquad \downarrow \\
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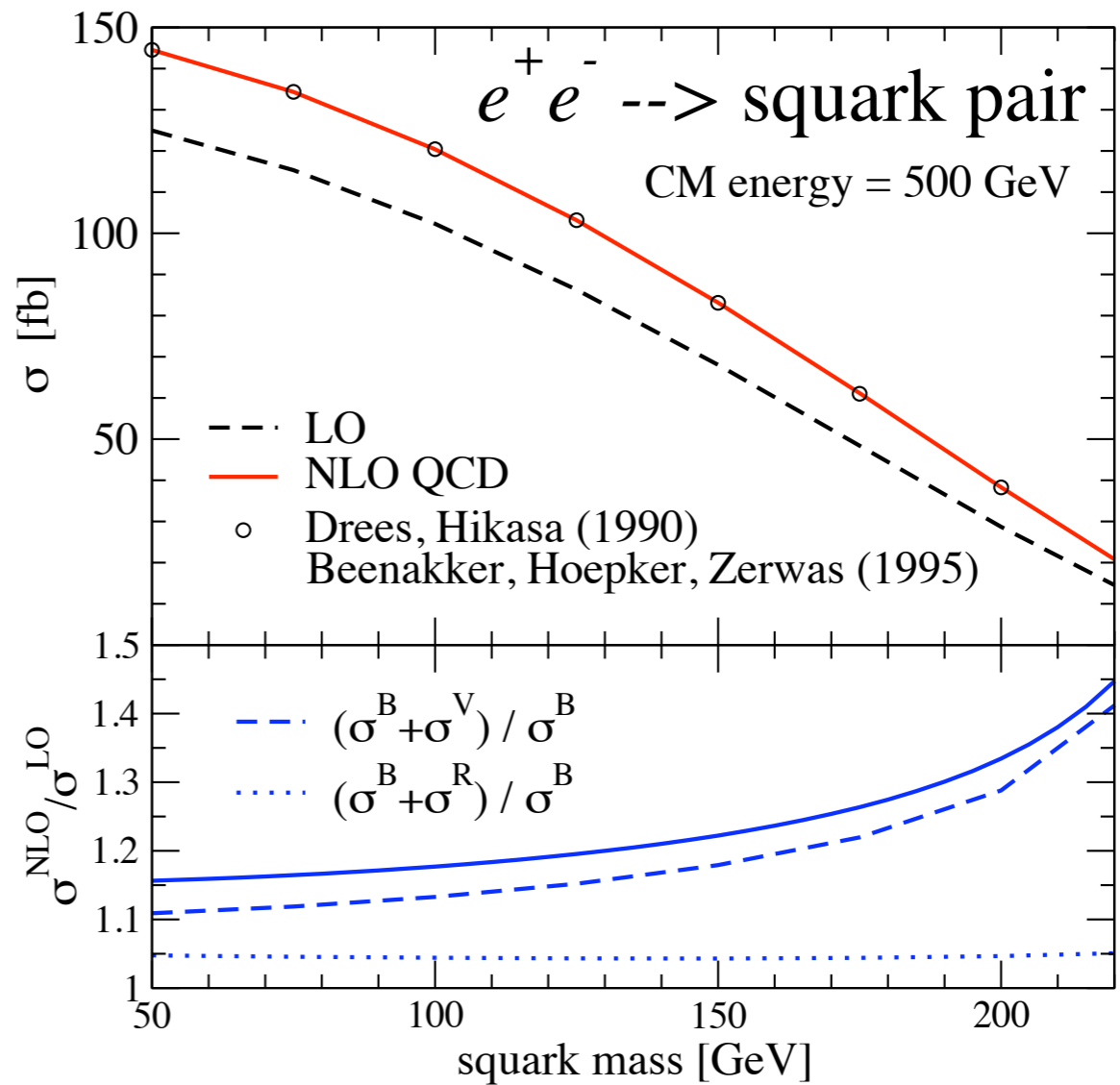
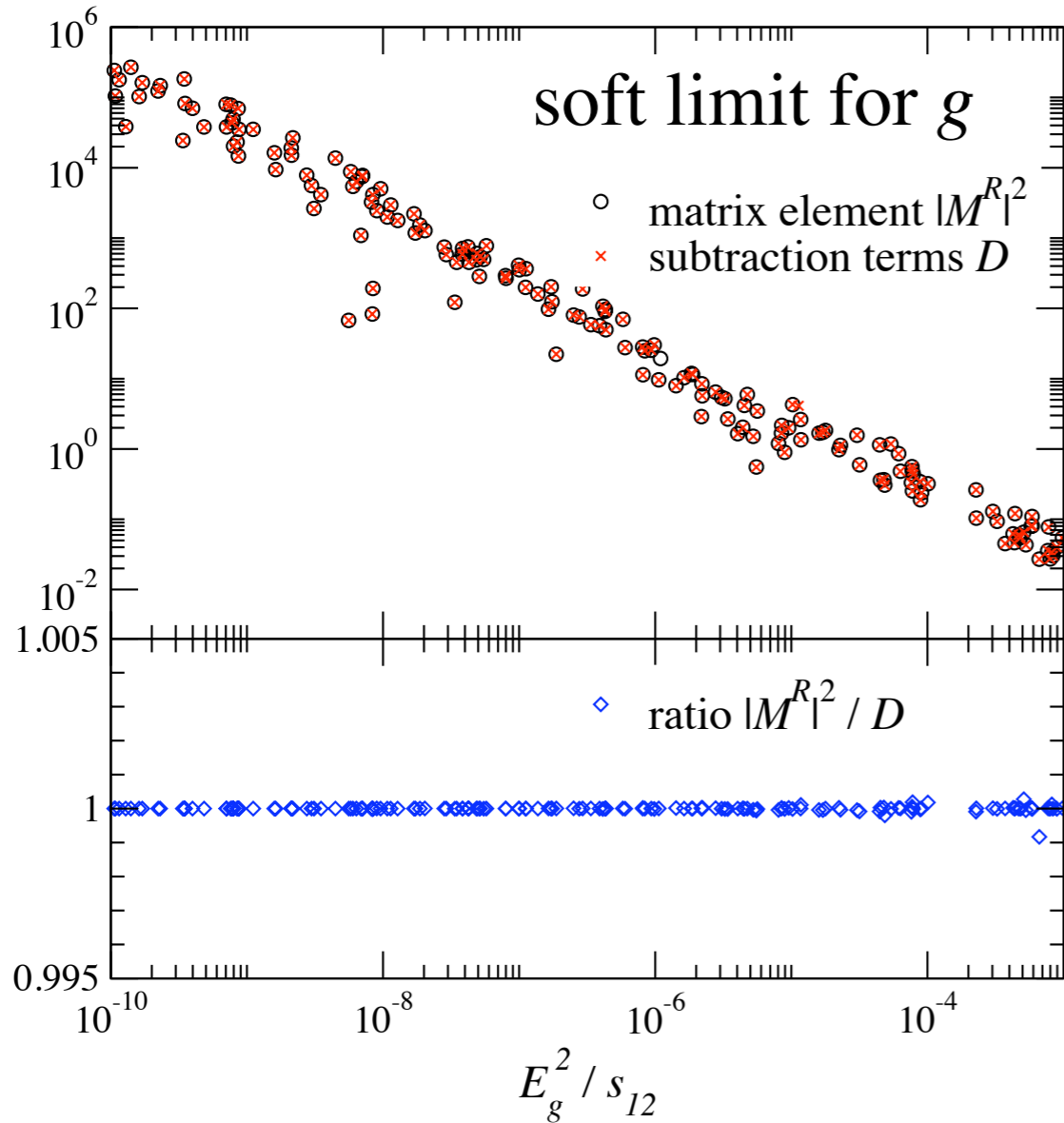
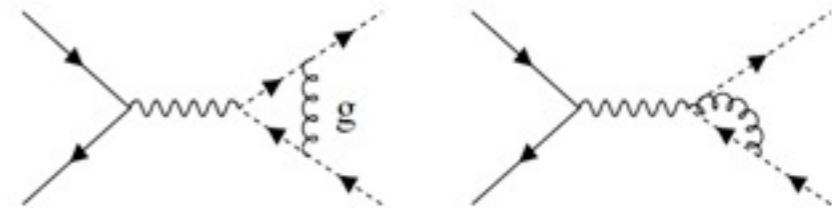
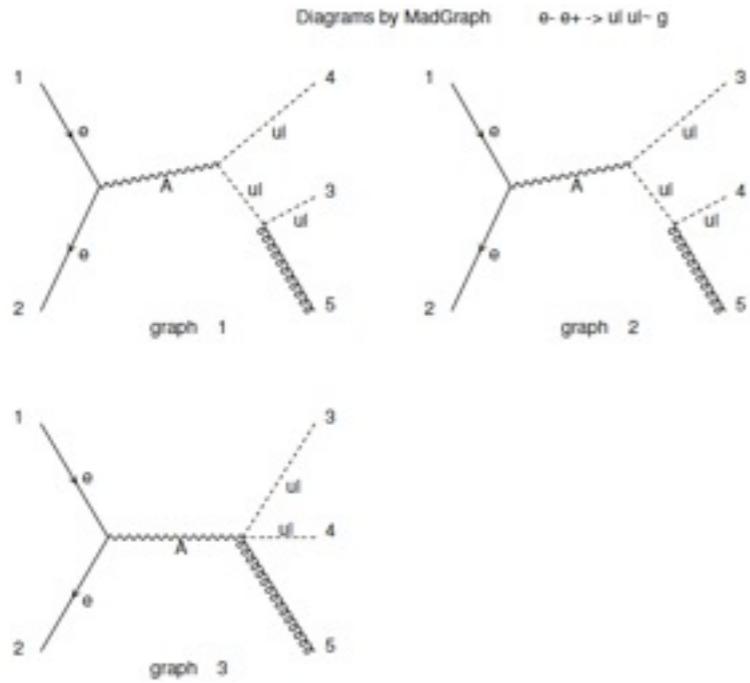
$$\begin{aligned}
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 \sigma & = & \int_m d\sigma^B + \int_{m+1} [d\sigma^R - d\sigma^A] + \int_m \left[ \int_1 d\sigma^A + d\sigma^V \right] \\
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 \end{aligned}$$

`param_card` (LHA format: masses, couplings, mixings)

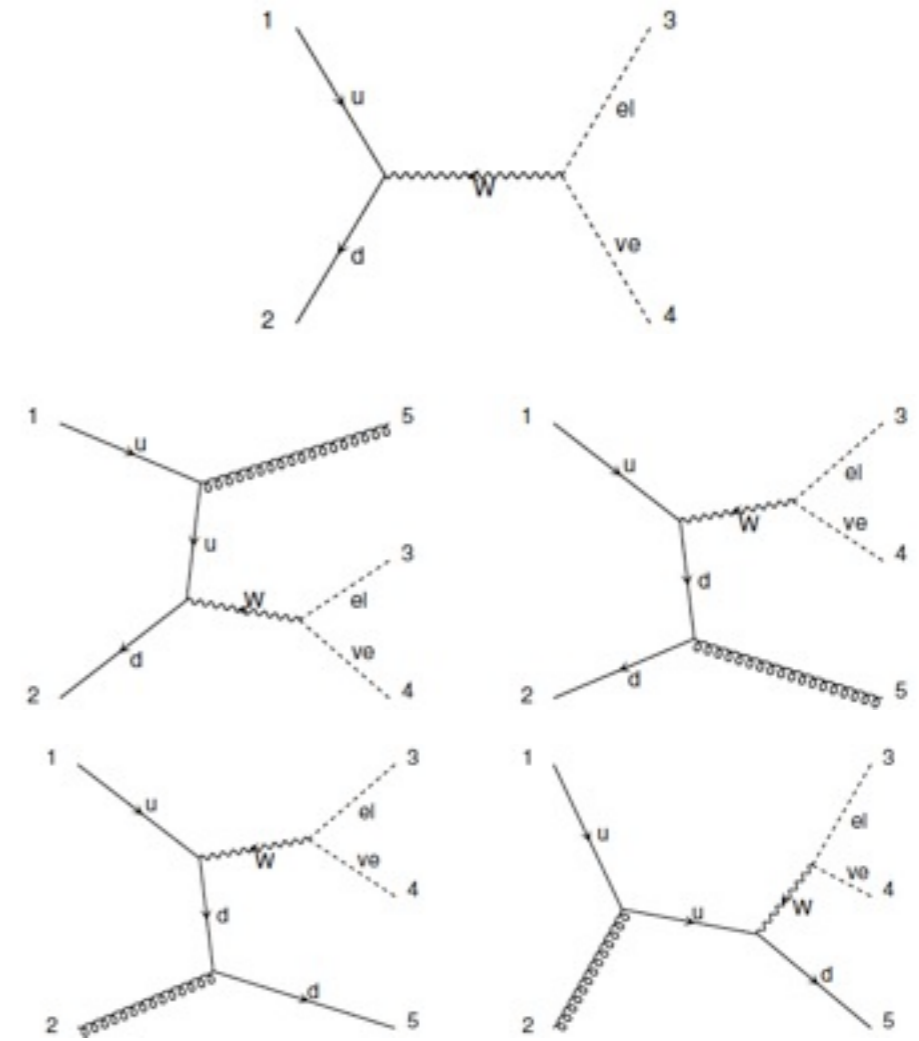
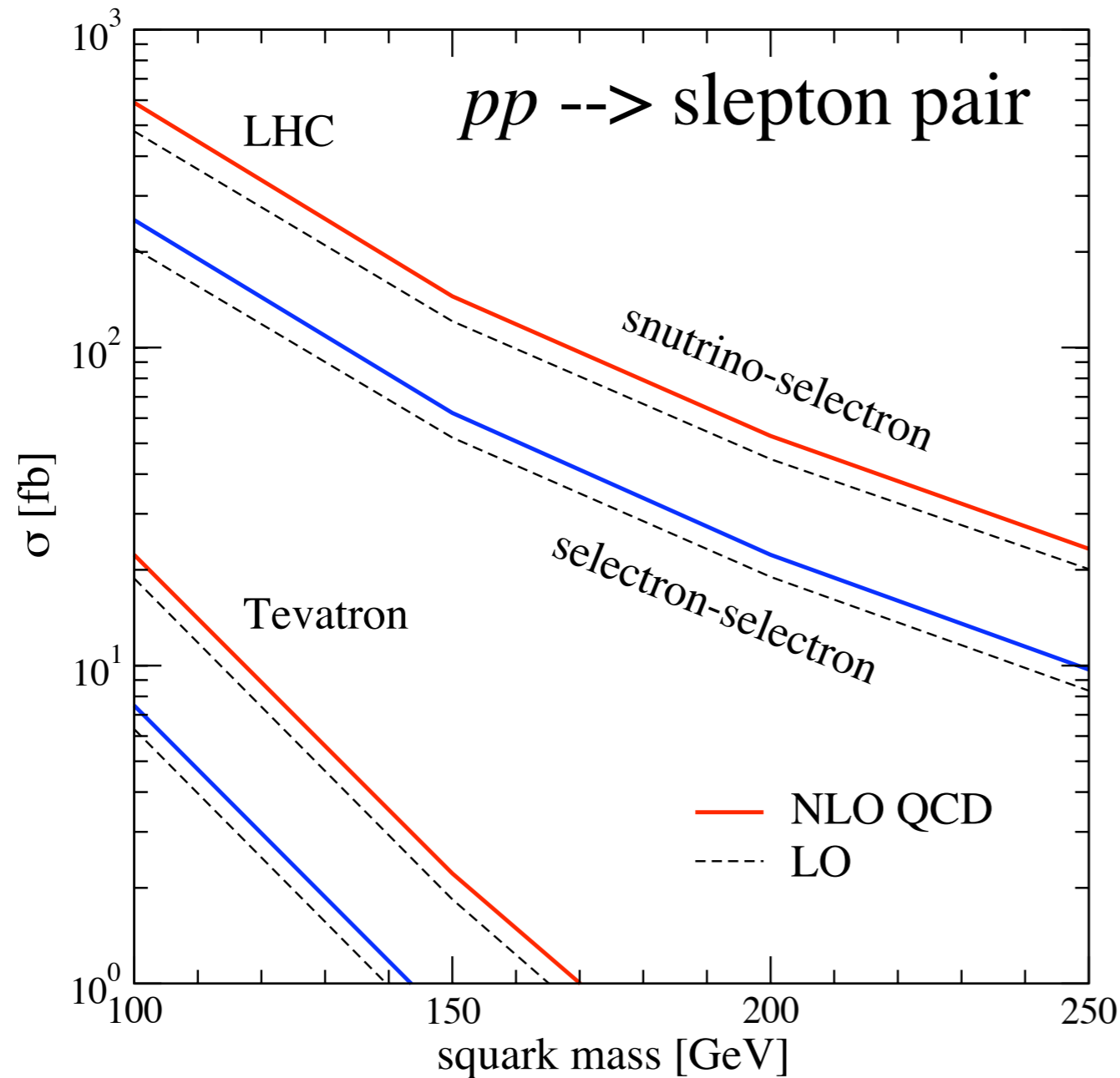
`run_card` (beam energy, renormalization/factorization scale, PDF, ...)



# SUSY-Dipoles



# NLO QCD corrections for SUSY pair productions at hadron colliders



$K \sim 1.35$  for LHC

$K \sim 1.25$  for Tevatron

Baer, Harris, Reno (1998)

Beenakker, Klasen, Kraemer,

Plehn, Spira, Zerwas (1999)

# Outlook

- Our main goal is the fully automatized NLO (SUSY-)QCD computations for SUSY pair productions in the MadNLO/GOLEM framework.
- The basic structure is simple, but there are many subtle issues for the interface: conventions, regularization schemes, cancellations of UV/IR divergences, counter terms, numerical integrations, Majorana particles, ...
- The code will be publicly available in the near future.