

# ESR20: WHY, WHAT, FIT IN THE NETWORK

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UCL, April 2-4 2014

Exploiting the physics potential of the LHC and future colliders requires the development of even more ingenious automated tools for precise calculations of more complicated multileg and/or multi-loop processes, including all those appearing on the experimentalists Les Houches NLO wish list as well as NNLO predictions for specific processes such as  $pp \rightarrow H+\text{jet}$ ,  $pp \rightarrow V+\text{jet}$ ,  $pp \rightarrow t\bar{t}$ ,  $pp \rightarrow VV$ . In anticipation of the discovery of New Physics, tools for the NLO QCD predictions for supersymmetric (SUSY) particle production and decays will also be developed.

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9/27/13 11:53 AM

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## HELAC-NLO & Associated Tools

**Projects**

- [HELAC-PHEGAS](#) - A generator for all parton level processes in the Standard Model
- [HELAC-DIPOLES](#) - Dipole formalism for the arbitrary helicity eigenstates of the external partons
- [HELAC-LOOP](#) - A program for numerical evaluation of QCD virtual corrections to scattering amplitudes
- [ONELOOP](#) - A program for the evaluation of one-loop scalar functions
- [CUTTOOLS](#) - A program implementing the OPP reduction method to compute one-loop amplitudes
- [FARNL](#) - A program for importance sampling and density estimation
- [KALEU](#) - A general-purpose parton-level phase space generator
- [HELAC-ONIA](#) - An automatic matrix element generator for heavy quarkonium physics

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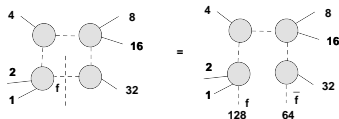
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Extending the OPP at two loops



- Reduction at the integral level (Algebraic Geometry, cutting equations)

$$\frac{N(l_1, l_2; \{p_i\})}{D_1 D_2 \dots D_n} = \sum_{m=1}^{\min(n,8)} \sum_{S_{m,n}} \frac{\Delta_{i_1 i_2 \dots i_m}(l_1, l_2; \{p_i\})}{D_{i_1} D_{i_2} \dots D_{i_m}}.$$

- Master Integrals via Simplified Differential Equation Approach

- The development of novel methods for the evaluation of two-loop amplitudes will be beneficial for and will benefit from other projects like ESR3, ESR8, ESR14, ESR15, ESR16, ESR17, ESR21
- Secondments: Three months to ALU-FR and ETH-Zurich for training in two-loop reduction methods, three months to FOM for training in amplitude construction. Secondment to the private sector, Maplesoft and Wolfran Research will be organized.