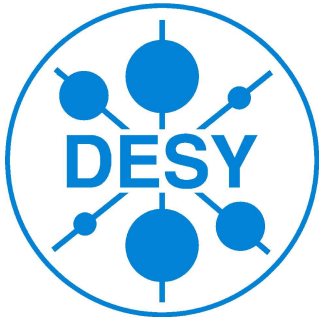
# Parton Distribution Functions

**Sven-Olaf Moch**

DESY


— *Meeting Analysis Centre groups - Management Board - DESY directorate* — May 04, 2009, Hamburg

# Research

## Theory work packages

- Activities at interface to experiments (LHC, Tevatron, ILC, HERA, . . . )
- Parton distribution functions
  - parton evolution with correlated errors
  - precise luminosity for proton–proton collisions at TeV-scale
- Hard scattering cross sections
  - predictions for key processes at Terascale (LHC and ILC)
  - collect known theory results for precision phenomenology

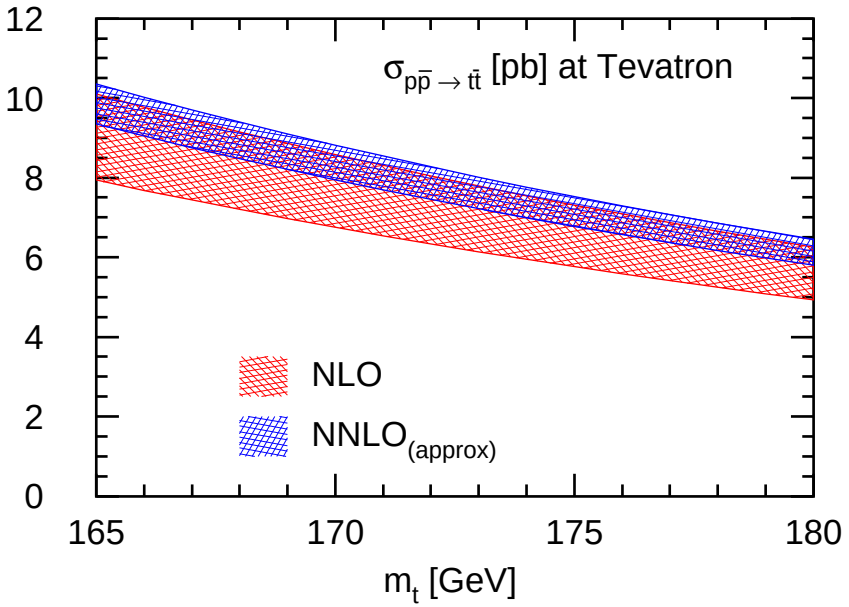
## Typical examples

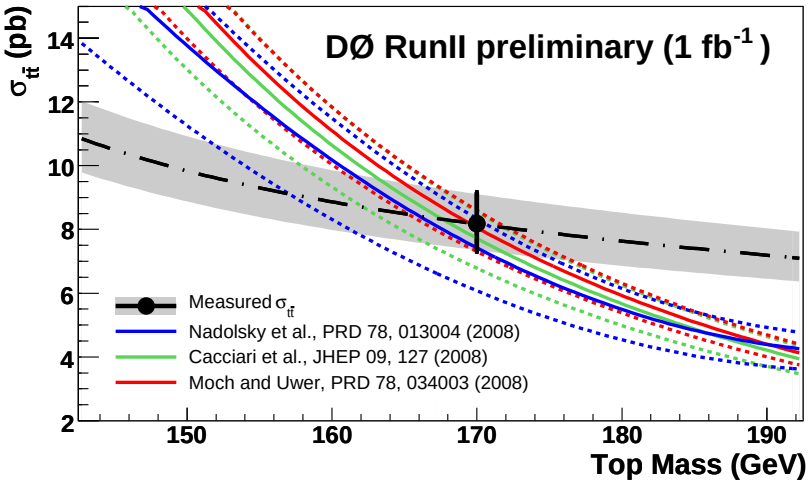
- Research triggerd by experiment – would not have happened without Alliance
  - top quark production at Tevatron/LHC S.M., P. Uwer `arXiv:0804.1476`
  - deep-inelastic heavy-flavor production Alekhin, S.M. `arXiv:0811.1412`

# Top-quark pair-production at NNLO

S.M., P. Uwer `arXiv:0804.1476`

- NLO (with MRST2006 PDF set)
  - scale uncertainty $\mathcal{O}(10\%)$ $\oplus$ PDF uncertainty $\mathcal{O}(5\%)$
- $\text{NNLO}_{\text{approx}}$ (with MRST2006 PDF set)
  - scale uncertainty $\mathcal{O}(3\%)$ $\oplus$ PDF uncertainty $\mathcal{O}(2\%)$



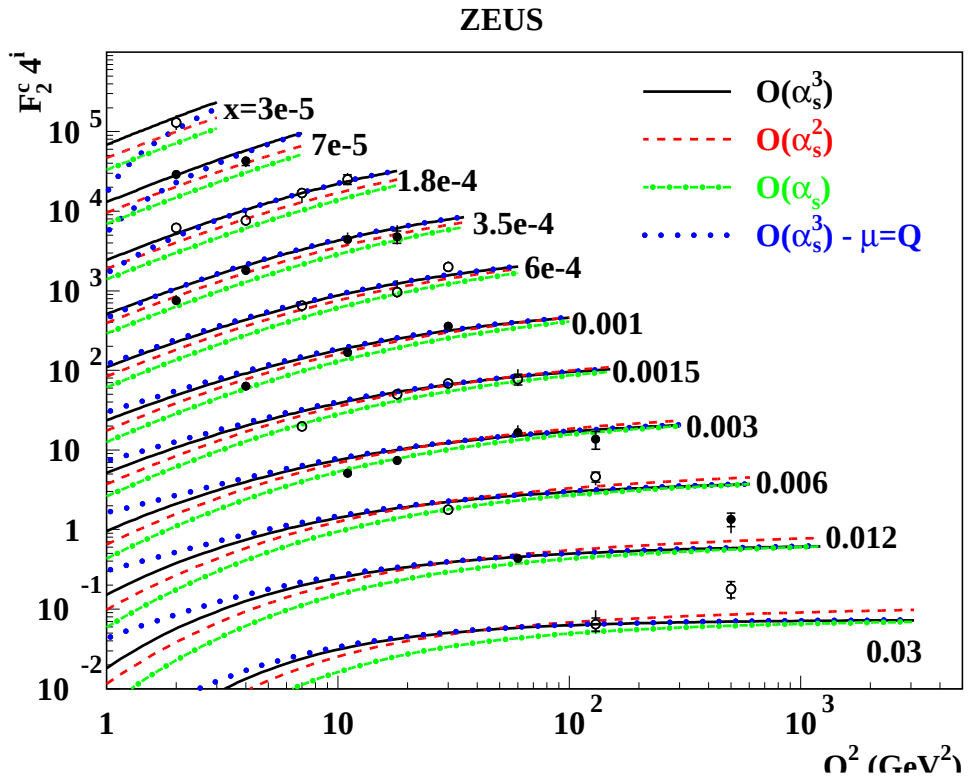




- NNLO allows for precision determination of $m_t$ from total cross section (slope $d\sigma/dm_t$) at Tevatron (DZero analysis)

# Global PDF fit with DIS heavy-flavor production

Alekhin, S.M. arXiv:0811.1412

- Threshold resummation for charm structure function $F_2^c$
- Perform global fit of PDFs at NNLO
  (variant of fit Alekhin, Melnikov, Petriello '06)
- Comparison with ZEUS data shows improvements in low $Q^2$-region at small values of $x$



# Activities

## Schools

- CAPP School on Computer-Algebra (bi-annual)

  S. Moch, T. Riemann, P. Wegner

- School on Parton Distribution Functions (annual)

  J. Blümlein, A. Glazov, S. Moch

HELMHOLTZ GEMEINSCHAFT

DESY

DESY School

Computer Algebra and Particle Physics
(CAPP 2009)

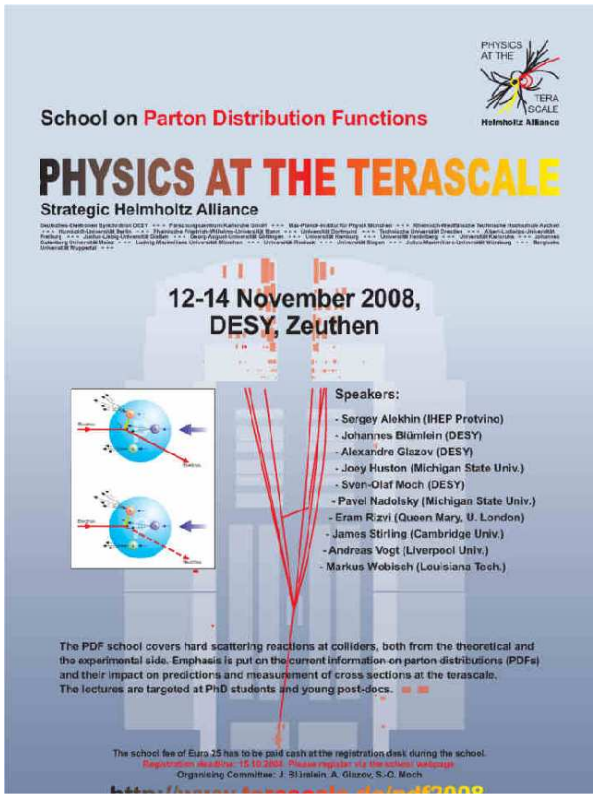
29 March – 3 April 2009
Zeuthen, Germany

During the last years, computer algebra methods have been used widely throughout elementary particle physics. Applications of modern computer algebra are an essential and established calculational tool and, at the same time, methods and algorithms of computer algebra have become an important area of research itself.

The CAPP school combines theory and practice in advanced environment. It provides education and training of about 30 students and young researchers at graduate and Ph.D. level on central topics at the interface of modern computer algebra and particle physics. The courses include exercises and practical training with software and programs, the hands-on part being a central component of the school.

Lectures and Courses

| | |
|---|---|
| D. Bailey (Berkeley Lab) | *Arbitrary precision numerics and the PSLQ algorithm* |
| J. Gluza (Katowice), T. Riemann (DESY) | *Integrals, Mellin-Barnes representations and Sums* |
| T. Hahn (MPI Munich) | *Mathematica and Symbolic Computing* |
| K. Hasegawa (DESY) | *Real parton emission and automated dipole subtraction* |
| R. Mertig (Wolfram Research) | *New features of Mathematica* |
| S. Moch (DESY) | *Computer algebra in particle physics* |
| C. Papadopoulos (INP Athens) | *Feynman integrals and the OPP reduction* |
| M. Steinhauser (Karlsruhe) | *Loop integrals, integration-by-parts and MATAD* |
| P. Uwer (HU Berlin) | *Efficient computing in particle physics* |
| J. Vermaseren (NIKHEF) | *Introduction to FORM* |
| M. Worek (Wuppertal) | *Helicity amplitudes and HELAC/PHEGAS* |



# The next steps

## Research aims

- Continue support of work at interface to experiment
  - update precision predictions for standard candle processes at LHC ($W/Z$-boson production, ...)
  - initiate new collaborations with Alliance theory fellows (e.g. with A. Kulesza on squark/gluino production)
  - provide public code (open source) for PDF evolution, cross section predictions, fast fitting etc.

## Schools

- School on Parton Distribution Functions
  - next school to be held in November 2009 in Hamburg

    J. Blümlein, A. Glazov, S. Moch

# How do we achieve this?

## People

- Work-load done by Ph.D. students, postdocs, guests, . . .
- E.g. U. Langenfeld (postdoc), P. Kovacikova (Ph.D.) funded by
  - Helmholtz YIG: VH-NG-105
  - SFB Transregio 9: Computational Particle Physics (Karlsruhe, Aachen, Berlin, Zeuthen)
  - EU MCRTN HEPTOOLS

## Funding requests

- Alliance support for schools and networking (guests, workshops, . . . )
- Alliance funds to continue work beyond fall 2010 (termination of EU MCRTN HEPTOOLS and Helmholtz YIG VH-NG-105)
  - request funding of one postdoc during 10/2010–09/2012