

COLLIDER PHYSICS

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+ NN

DESY



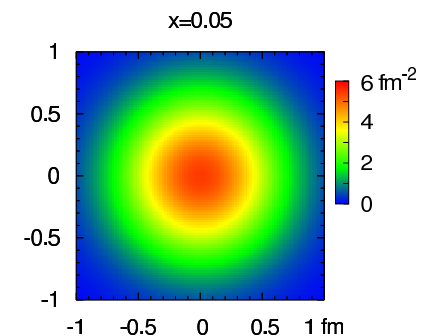
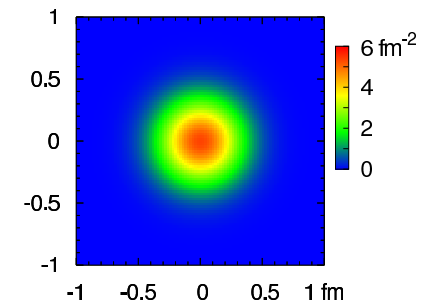
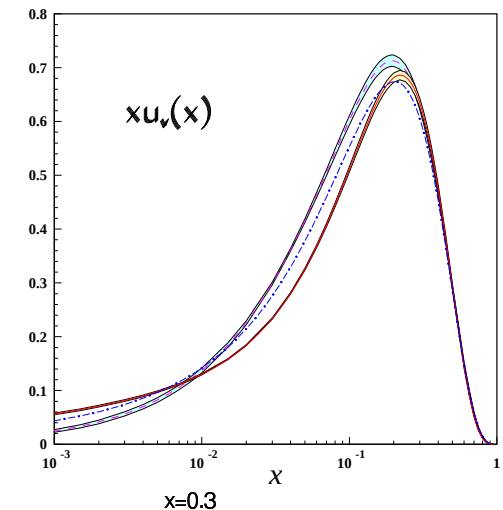
HERA

Our assets

- Precision predictions for DIS structure functions
 - splitting functions
 - Wilson coefficients at 3 loops
 - effects of heavy quarks (charm, bottom)

Parton distributions functions

- PDFs for the LHC
 - parton evolution with correlated errors
 - precise luminosity for proton–proton collisions at TeV-scale
- Generalized PDFs ('3d imaging of proton')
 - details of transverse proton structure
 - multiple parton scattering at LHC
 - affects hadronic final state



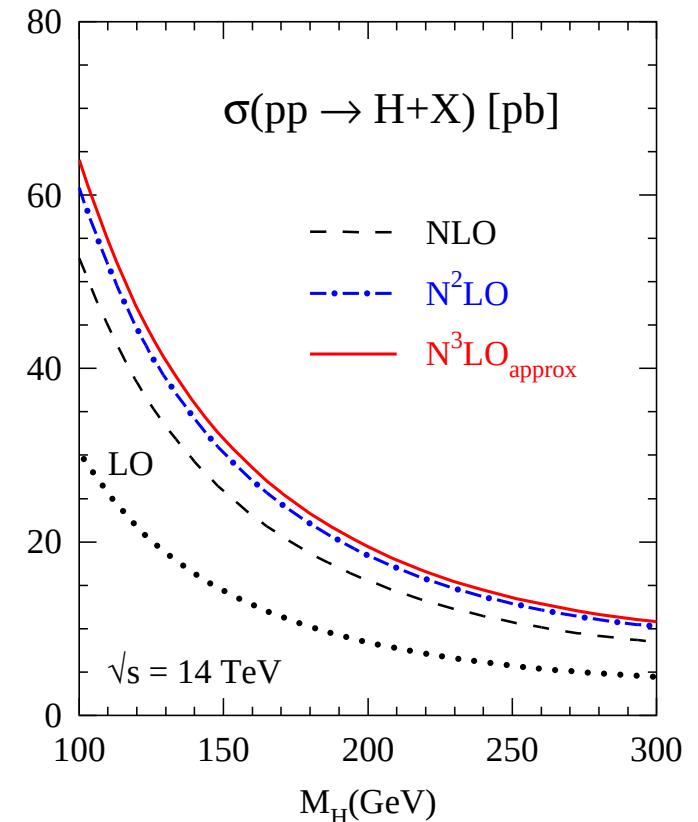
LHC (I)

Terascale Physics

- Phenomenology for successful new physics searches *Analysis Center*
- High precision prediction for scattering processes in SM and beyond
 - e.g. Higgs boson production from gluon-gluon fusion
 - QCD: large K -factors
cross section ratio $NLO/LO \sim \mathcal{O}(2)$

Future

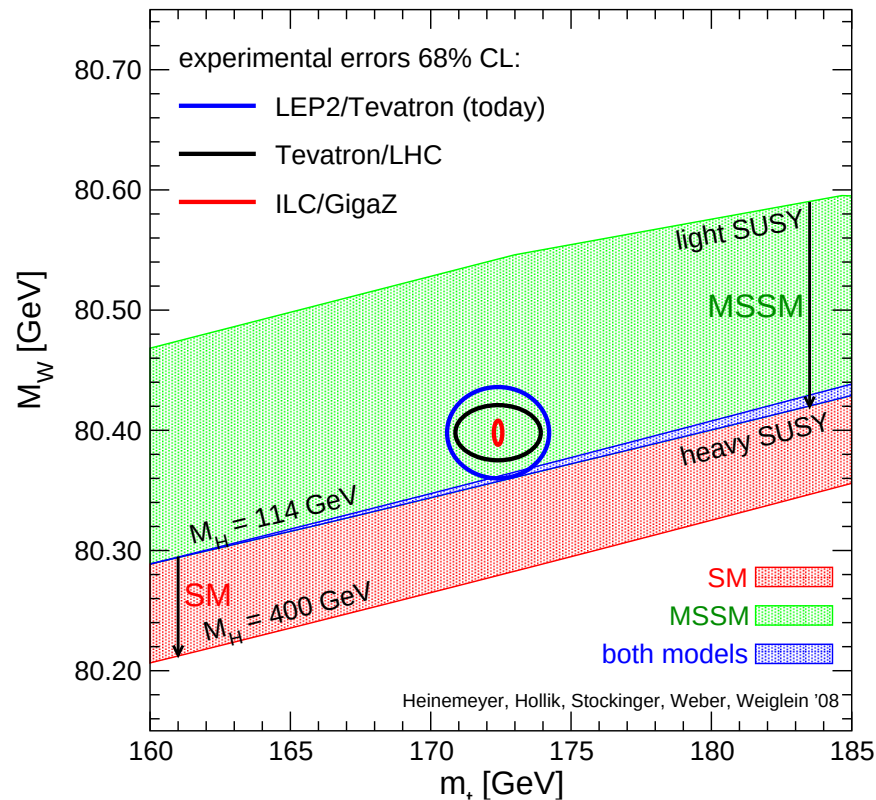
- High-multiplicity final states
 - typical SM process is accompanied by radiation of multiple jets
 - NLO computations
 - real corrections (divergences, automated subtraction)
 - virtual corrections (new technology, on-shell methods)



LHC (II)

New physics searches

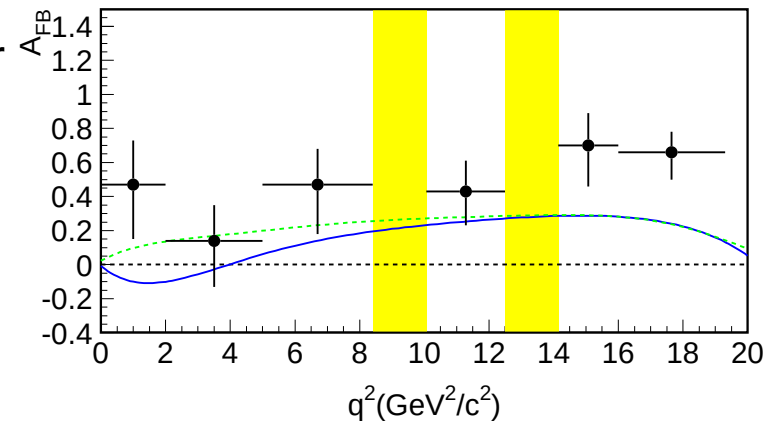
- High precision constraints on SM and MSSM (Higgs sector)
 - radiative corrections relate M_W , m_t and M_H
- Mechanisms of electroweak symmetry breaking



Flavour Physics

Topics

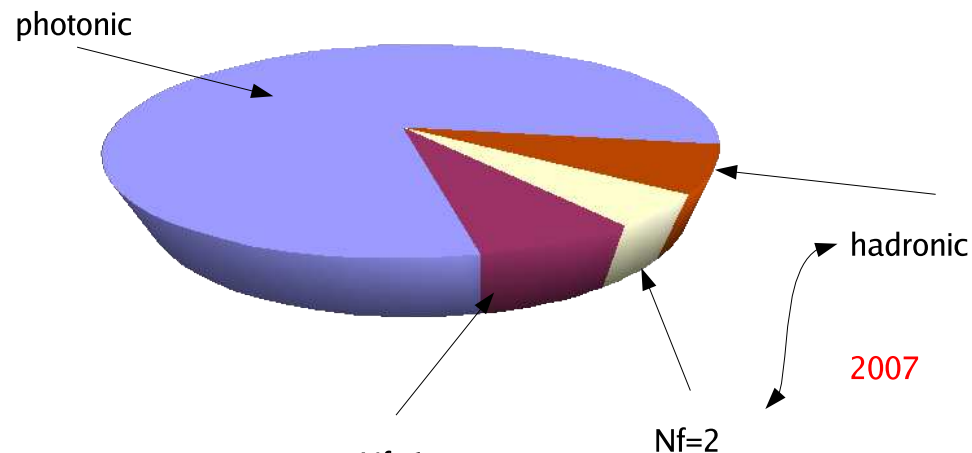
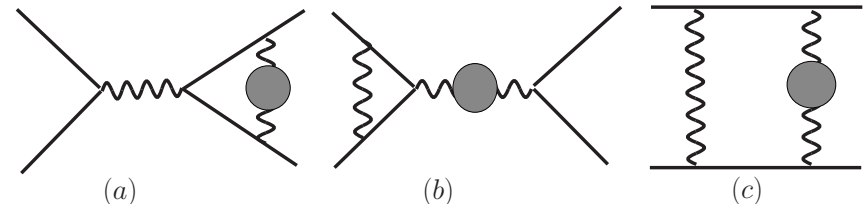
- CP -violation, rare B -decays, V_{CKM}
- Precision theoretical calculations
 - HQET, SCET, QCD Sum Rules, ...
 - standard references in the interpretation of data (B -factories, Tevatron, LHC)
- Searches for BSM physics in flavour sector
 - e.g. forward-backward asymmetry for rare decays
 $B \rightarrow K^{(*)} \ell^+ \ell^-$
- Neutrinoless Double Beta Decays (lifetimes, angular correlations)



ILC

The Road ahead

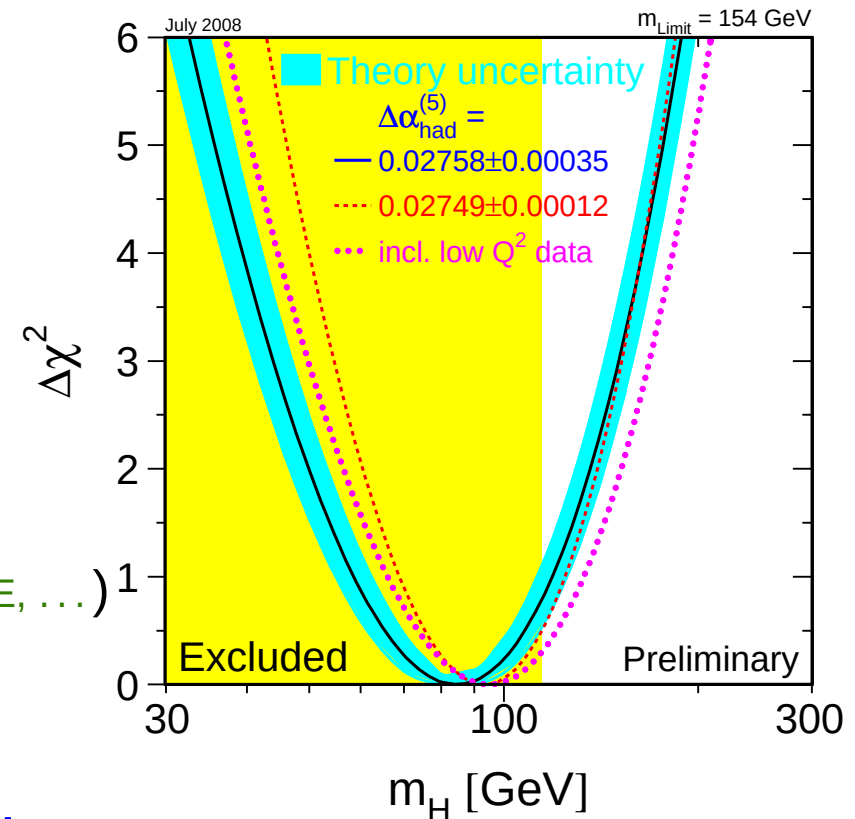
- Bhabha scattering to monitor luminosity: $\mathcal{L} = N_{Bhabha} / \sigma_{Bhabha}$
- Forward calorimeter (FCAL) project prepares detector element at very small angles (few degrees) for ILC and GigaZ with $\delta\mathcal{L}/\mathcal{L} \sim 10^{-4}$
- Precision theory for Bhabha scattering required
 - QED radiative corrections at 2 loops required
 - progress during last 2 years
- Theory prediction: error budget of various contributions



Tools

Technology

- Mathematics: new technology for multi-loop/leg problems
- Computer algebra systems (Form, Maple, Mathematica, ...)
 - applications (AMBRE, XSummer, ...)
- Experimental analyses: long tradition in development of tools (HECTOR, ZFITTER, Prospino, Whizard, CASCADE, ...)
 - long term support and responsibility



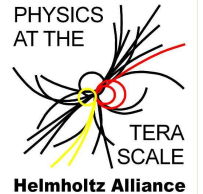
Collaboration with Analysis Center

- Monte Carlo tools for LHC
 - parton shower, underlying event, NLO+parton shower

Alliance: Physics at Terascale

Key idea

- Theory work packages and activities at interface to experiments
 - Monte Carlo, PDFs, ...
 - Service tasks: education, schools, workshops, discussion days, ...



Strategic networking

- German universities
 - theory funds used entirely to strengthen collider physics at universities
 - large leverage through additional funds from universities
- Strategic support
 - YIGs: e.g. Berlin, Göttingen, Karlsruhe, Wuppertal
 - Fellowships

Activities (I)

Workshops

- Support for particle physics in Germany, Europe, . . .
 - DESY Theory Workshop (annual)
 - Conference series “Loops and Legs” (bi-annual)

 **DESY THEORY WORKSHOP**
SEPTEMBER 27 - 30, 2005
DESY, Hamburg, Germany

QUANTUM CHROMODYNAMICS

From the MeV to the TeV Scale

INTRODUCTORY LECTURES Sept. 27, 2005

M. Diehl (DESY)	T. Gehrmann (Zürich)
T. Schäfer (Stony Brook)	R. Sommer (DESY)

PLENARY SESSIONS Sept. 28-30, 2005

M. Beneke (Aachen)	S. Katz (Budapest)	S.-O. Moch (DESY)
V. Chekelian (MPI München)	E. Klempt (Bonn)	A. Penin (Karlsruhe)
K. Chetyrkin (Karlsruhe)	F. Knechtli (Berlin)	M. Ryskin (St. Petersburg)
A. Drees (Stony Brook)	D. Kosower (Saclay)	I. Shovkovy (Frankfurt)
J. Forshaw (Manchester)	V. Lubitz (Rome)	U. Wiedemann (CERN)
J. Gasser (Bern)	K. Melnikov (Hawaii)*	F. Wilczek (MIT)
L. Giusti (CERN)	M. Misiak (Warsaw)	D. Zeppenfeld (Karlsruhe)
R. Harlander (Wuppertal)		

* to be confirmed

DESY Heinrich-Hertz Lecture on Physics: F. Wilczek (MIT)
 $m=E/c^2$: The Origin of Mass

PARALLEL SESSIONS

Mainly reserved for young researchers. Contributions should be sent to the Chairman before July 8th.
Limited financial support for young physicists is possible.

ORGANIZING COMMITTEE

J. Bartsch
W. Bernreuther
A. Buss
Z. Fodor
R. D. Heuer
J. Kühn (Chairman)
U.-G. Meißner
D. H. Reischke
A. Schäfer

REGISTRATION

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Fax +49-721-6063369

9th DESY Workshop on
Elementary Particle Theory

 **LOOPS AND LEGS IN QUANTUM FIELD THEORY**

Sondershausen, Germany, April 20 - 25, 2008



Programme Committee

S. Catani, L. Dixon, R. Ellis, J. Fajfer, T. Gehrmann, E.W.K. Glover, J. Gluza, W. Hollik, B.A. Kniehl, M. Mangano, C. Papadopoulos, T. Riemann, J.A.M. Vermaseren, N. Kniehl, R. Rosales, SLAC, FNAL, KEK, Zurich, DESY, Karlsruhe, MPI Munich, RWTH Aachen, CERN, Albert-Ludwigs-Universität, Bonn, DESY, J. Blümlein, S. Moch, T. Riemann (Chair), http://www.desy.de/LL2008

J. Meyer, Marktplatz Sondershausen (um 1840) © Schlossmuseum Sondershausen

Activities (II)

Schools

- Education and training of young scientists
 - Helmholtz International School (DESY, GSI, JINR Dubna) (annual)
 - CAPP School on Computer-Algebra (bi-annual)
 - School on Parton Distribution Functions (annual)



Helmholtz International School - Workshop
Calculations for Modern and Future Colliders
 July 10 - 20, 2009, Dubna, Russia

TOPICS:

- Precision calculations for experiments at Tevatron, LHC, etc.
- Multiloop calculations, resummation techniques
- Computer codes
- Phenomenology and search for new physics at hadron colliders
- Physics at ILC and experimental tags for theory

Organizing Committee

D. Kazakov (JINR) - Chairman
 T. Riemann (DESY, Zeuthen) - Co-Chairman
 D. Bardin (JINR)
 A. Bednyakov (JINR) - Scientific Secretary
 T. Donskova (JINR) - Secretary
 A. Gladyshev (JINR)
 L. Kalinovskaya (JINR)
 S. Moch (DESY, Zeuthen)
 J. Schmelzer (JINR & Uni Rostock)
 I. Smirnova (JINR, Dubna)

Lectures

A. Belyaev (Southampton University, UK)
 J. Fleischer (DESY, Zeuthen & Bielefeld Uni, Germany)
 A. Grozin (INP, Novosibirsk, Russia)
 T. Hahn (MPI, Munich, Germany)
 S. Heinemeyer (CSIC-UC, Santander, Spain)
 S. Lola (Patras University, Greece)
 J. Mnich (DESY, Hamburg, Germany)
 A. Pukhov (SINP, Moscow, Russia)
 T. Riemann (DESY, Zeuthen, Germany)
 V. Smirnov (SINP, Moscow, Russia)
 P. Uwer (Humboldt Uni, Berlin, Germany)

<http://theor.jinr.ru/~calc2009>



DESY School on Computer Algebra and Particle Physics (CAPP 2007)

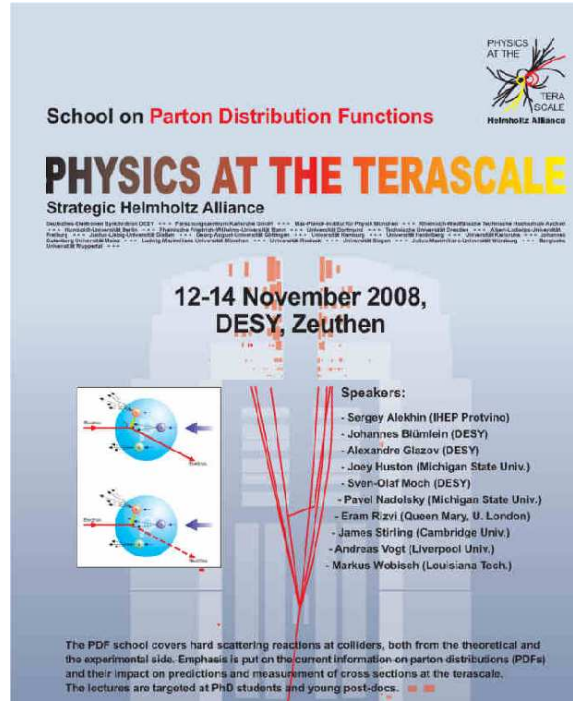
March 25 - 30, 2007
Zeuthen, Germany

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.

Lectures and Courses

F. Bornemann (TU Munich)	<i>The SIAM 100-Digit Challenge</i>
N. Glover (IPPP Durham)	<i>On the Why's and How's of Perturbation Theory</i>
J. Gluza (Katowice), T. Riemann (DESY)	<i>Feynman Integrals and Mellin-Barnes Representations</i>
T. Hahn (MPI Munich)	<i>Introduction to Mathematica and Algorithms for Numerical Integration</i>
R. Harlander (U. Wuppertal)	<i>Algebraic Methods for Multi-loop Integrals</i>
F. Maltoni, M. Herquet (U. Louvain)	<i>Introduction to MadGraph/MadEvent</i>
R. Mertig (Wolfram Research)	<i>New Features of Mathematica</i>
S. Moch (DESY), C. Schneider (RISC)	<i>Algorithms for Symbolic Summation</i>
J. Vermaseren (NIKHEF)	<i>Introduction to FORM</i>
S. Weinzierl (U. Mainz)	<i>Basic Concepts and Algorithms of Computer Algebra</i>

Organising Committee: S. Moch, T. Riemann, P. Wegner



School on Parton Distribution Functions

PHYSICS AT THE TERASCALE
 Strategic Helmholtz Alliance

12-14 November 2008, DESY, Zeuthen

Speakers:

- Sergey Alekhin (BHEP Protvino)
- Johannes Blümlein (DESY)
- Alexandre Glazov (DESY)
- Joey Huston (Michigan State Univ.)
- Sven-Olaf Moch (DESY)
- Pavel Nadolsky (Michigan State Univ.)
- Eram Rizvi (Queen Mary, U. London)
- James Stirling (Cambridge Univ.)
- Andreas Vogt (Liverpool Univ.)
- Markus Wobisch (Louisiana Tech.)

The PDF school covers hard scattering reactions at colliders, both from the theoretical and the experimental side. Emphasis is put on the current information on parton distributions (PDFs) and their impact on predictions and measurement of cross sections at the terascale. The lectures are targeted at PhD students and young post-docs.

Third party funds

Helmholtz

- Helmholtz Alliance: Physics at the Terascale (HA-101)
- YIG: Computer algebra and higher orders in particle theory (VH-NG-105)

DFG

- SFB Transregio 9: Computational Particle Physics (Karlsruhe, Aachen, Berlin, Zeuthen)
- SFB 676: Particles, Strings and the Early Universe (Hamburg)
- GK 602: Graduiertenkolleg (Hamburg)
- GK 1504: Graduiertenkolleg (Berlin, Dresden, Zeuthen)

EU

- MCRTN HEPTOOLS

Humboldt

- Fellowships and Humboldt prizes

Summary

Research

- Precision predictions for collider observables
 - close contact to experiment (LHC, Tevatron, ILC, HERA, B -factories)
- Higgs phenomenology at LHC
- Signatures of MSSM and other BSM models
 - high multiplicity final states
 - collaboration with Monte Carlo activities [Analysis Center](#)
- Structure functions and PDFs: HERA data and impact of LHC data

Key strategic items

- Strong support for PhD students and DESY Fellowship program
- Strengthen role in Helmholtz Alliance [Analysis Center](#)

