# Lucia Hošeková


## Contact Information

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## Personal Information

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| *Date of Birth:* | 19 April 1984 |
| *Citizenship:* | Slovak |
| *Marital Status:* | single |

## Education

**PhD. in physics** January 2008 to September 2012

Institute for Theoretical Physics, University of Zurich, Switzerland

- Thesis Topic: *NLO QCD Corrections to the Production of Two Lepton Pairs via Vector-Boson Fusion at the LHC*
- Adviser: Prof. Ansgar Denner
- Area of Study: Theoretical High-Energy Physics

**MSc. in physics** June 2007

Comenius University, Bratislava, Slovakia
and HEPHY, Austrian Academy of Sciences, Vienna, Austria

- Thesis Topic: *One-Loop Calculations of the Decay of a Neutral Higgs Boson into Two Photons in the MSSM*
- Adviser: Dr. Karol Kovařík
- Area of Study: Theoretical and Mathematical Physics

**High School** June 2002

Grammar School Billikova, Bratislava, Slovakia

## Academic Appointments

**Junior Math Developer (Secondment)** January 2013 to present

Maplesoft, Waterloo, Canada

**LHCPhenoNet ESR fellow** November 2011 to present

Instituto de Física Corpuscular IFIC, Valencia, Spain

**HEPTools ESR fellow** October 2007 to October 2011

Paul Scherrer Institut, Villigen, Switzerland

## Fellowships

- 10/2006 - 03/2007 - Austrian Exchange Service fellowship
- 10/2007 - 10/2010 - HEPTOOLS Marie Curie Research Training Network fellowship
- 11/2011 - present - LHCPhenoNet Marie Curie Research Training Network fellowship

## Awards

- Comenius University, Bratislava, Slovakia
  Dean's Distinguished Master's Thesis Award

## Further Education

Graduate schools:

- *Third Graduate School in Physics at Colliders*, Torino, Italy
- *PSI Summer School on Particle Physics - New Ideas in Particle Physics*, Zuoz, Switzerland
- *High Energy Physics Summer School*, Svit, Slovakia
- *MC4LHC Workshop: From Parton Shower to NNLO*, CERN, Switzerland
- *Corfu Summer Institute School and Workshops on Cosmology, Strings, Phenomenology*, Corfu, Greece
- *Fourth Graduate School in Physics at Colliders*, Torino, Italy
- *PSI Summer School on Particle Physics - Gearing up for LHC Physics*, Zuoz, Switzerland
- *LHCPhenoNet Winter School 2012*, Ascona, Switzerland

## Teaching Experience

University of Zurich, Switzerland
Courses assisted:

- Mechanics, FS 2008
- Mathematical Methods in Physical Sciences I, Fall Semester 2009 and Fall Semester 2010
- Mathematical Methods in Physical Sciences II, Spring Semester 2009 and Spring Semester 2010

## Language Skills

- English (fluent), German (intermediate), Spanish (beginner), Slovak and Czech (native)

## Computer Skills

- Programming: Fortran, C++, Java
- Applications: Mathematica, Maple, LaTeX, FormCalc, MadGraph, most common productivity applications for UNIX and MS Windows

## Papers

A. Denner, L. Hošeková, S. Kallweit
*NLO QCD corrections to W+ W+ jj production in vector-boson fusion at the LHC*
*Phys. Rev. D 86: (2012) 114014*

## Talks

- *One-loop Calculation of the Decay of a Higgs Boson into Two Photons in the MSSM*
  seminar given at PSI, Switzerland, 12 July 2007

- *NLO QCD Corrections to Gauge Boson Scattering at the LHC*
  talk given at HEPTOOLS 2nd Annual Meeting, Lisbon, Portugal, 10 March 2009

- *NLO QCD Corrections to Gauge Boson Fusion Processes at the LHC*
  talk given at HEPTOOLS Final Meeting, Granada, Spain, 26 November 2010

- *NLO QCD Corrections to Gauge Boson Fusion Processes at the LHC*
  seminar given at IFIC Valencia, Spain, 5 May 2011

- *NLO QCD Corrections to the Gauge Boson Scattering Processes at the LHC*
  talk given at LHCPhenoNet Annual Meeting 2012, Lumley Castle, UK, 20 March 2012

- *NLO QCD Corrections to the Production of Two Lepton Pairs via Vector-Boson Fusion at the LHC*
  seminar given at IFIC Valencia, Spain, 7 September 2012

- *NLO QCD Corrections to the Production of Two Lepton Pairs via Vector-Boson Fusion at the LHC*
  seminar given at PSI, Switzerland, 11 September 2012

- *NLO QCD Corrections to Gauge Boson Production via Vector-Boson Fusion at the LHC*
  seminar given at IFT Madrid, Spain, 26 November 2012

- several lectures for undergraduate students at University of Zurich covering topics from Mathematical Methods in Physical Sciences

## Research Interests

LHC phenomenology, computer algebra, multi-leg calculations, loop calculations

## References


- Prof. Ansgar Denner
  Institute for Theoretical Physics and Astrophysics
  Würzburg University
  denner@physik.uni-wuerzburg.de

- Dr. Germán Rodrigo
  Instituto de Física Corpuscular IFIC
  Consejo Superior de Investigaciones Científicas CSIC
  german.rodrigo@csic.es

- Dr. Karol Kovařík
  Institut for Theoretical Physics
  Karlsruhe Institute of Technology
  kovarik@particle.uni-karlsruhe.de

# Lucia Hošeková - Publications

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A. Denner, L. Hošeková, S. Kallweit
*NLO QCD corrections to W+ W+ jj production in vector-boson fusion at the LHC*
arXiv:1209.2389
*Phys. Rev. D 86: (2012) 114014*

# Lucia Hošeková - Research Interests

Quantum field theory has proven to be today's most effective way to describe and analyze how the universe works at the submicroscopic level. Combined with perturbation theory, it has produced the most precise and unprecedentedly accurate description of the natural world as we observe it. Precision computations in QCD are, in my opinion, one of the most exciting areas of physics, as they play an important role in extracting experimental data from the LHC while presenting the theorists with a great challenge due to the need for amplitudes at higher perturbative orders and many external legs to obtain the desired accuracy for predictions. Recent years have seen many new tools and techniques being developed that allowed substantial progress in implementing such calculations, especially when dealing with many jets, multi-loops and large number of external fields.

My master project, conducted under supervision of Dr. Karol Kovařík, has introduced me to the basic methods and tools used in today's high precision physics. My work involved both analytical and numerical components, starting with a thorough derivation of the MSSM Lagrangian by constructing the supersymmetric generators, working my way towards writing down a generic supersymmetric model, identifying the Standard Model fields and their supersymmetric partners and including the soft supersymmetry-breaking terms. We proceeded by applying the MSSM to calculate a simple one-loop process, decay of Higgs boson into two photons, both by hand and using automatized tools.

During my PhD studies, my supervisor Prof. Ansgar Denner turned my attention towards vector-boson fusion (VBF) processes which have a potential to provide a valuable insight not only while confirming the existence of the Standard Model Higgs boson, but also into many of its characteristics, including decay width, CP properties and its couplings to both fermions and gauge bosons. My project involved calculation of the NLO QCD corrections to vector boson scattering processes at the LHC and comparison with previously published results of Dieter Zeppenfeld and his collaborators. These processes are invaluable to the Higgs search as they dominantly contribute to the background for Higgs production via VBF.

From the computational point of view, NLO corrections to the VBF processes with a full leptonic decay pose a challenging problem as one needs to find a way to deal with six particles in the final state and organize the large number of Feynman diagrams that are involved. Our approach to handling this increased complexity lies in creating a database of subdiagrams which can be treated in a completely independent fashion and combined to obtain the full matrix elements. The structure of the VBF diagrams allows us to decompose them into purely QCD and electroweak blocks which means we can obtain both the leading and the next-to-leading order QCD corrections without having to reevaluate the electroweak subdiagrams each time.

The individual blocks are generated in Mathematica using FeynArts and FormCalc, modified to incorporate the Weyl van der Weerden formalism and various abbreviations and finally exported as Fortran subroutines. Implementing the block structure by cutting all internal vector bosons that couple to the quark lines in the diagrams allows us to not only save CPU time

by evaluating each required block only once, but also to keep the number of required blocks relatively small by reusing them in multiple instances throughout all diagrams and even partonic processes. The Fortran code for each process is contained in a single function that can be called from within a Monte Carlo program and returns an array of full squared amplitudes for each partonic process, including all relevant colour and averaging factors.

We have applied this method to obtain both resonant and non-resonant contributions to the NLO QCD corrections to $pp \to e^+\nu_e\mu^+\nu_\mu jj$, a process associated with production of intermediate $W^+W^+$ pair with subsequent leptonic decay and compared the numerical results for the cross section as well as kinematical distributions with published results by Zeppenfeld et al. We introduced a new dynamic scale with improved behaviour for energy-dependent distributions and quantitatively assessed the sizes of $s$-channel and interference contributions after applying a set of typical VBF cuts. Our future plans include producing similar results for the VBF processes associated with the production of intermediate $W^+Z$, $ZZ$ and $W^+W^-$ pairs, as well as exploring the possibility of implementing electroweak NLO corrections in the setup we created. This would require introducing additional types of loop diagrams which cannot be factorized into independent blocks and therefore their calculation requires employing different methods. My database of building blocks can be easily expanded to incorporate additional subdiagrams and new fields, thus giving us access to other multi-leg calculation and possibly including beyond Standard Model physics.

My interests and previous experiences lie in collider phenomenology and cover mainly loop and multi-leg calculations in the Standard Model and supersymmetry and their automatization, as well as techniques involved in combining NLO calculations with multichannel Monte Carlo event generators. I am ready to welcome any opportunity to work in a new team of colleagues where I'll have a chance to contribute my own experiences and, at the same time, expand my knowledge by working on new projects and facing problems and challenges from other areas of particle phenomenology.