

Agnieszka Ilnicka

ESR14, ETH node

supervised by: G. Dissertori (ETH), M. Grazzini (UZH), M. Spira (PSI)



ETH zürich



University of
Zurich^{UZH}

PAUL SCHERRER INSTITUT



Mid Term Review, Brussels, 2015

Background

- From Warsaw, Poland
- Studied at:
 - College for Inter-Faculty Individual Studies in Mathematics and Natural Sciences, University of Warsaw, 2007-2014
 - Faculty of Exact Sciences, VU University Amsterdam, 2011-2013



- Taking courses from programmes of Physics, Chemistry and Mathematics
- MSc Diploma in Particle Physics from UW in 2013



Project and Work Package Architecture

- My project belongs to **WP2 Predictions and simulations of signal and background**
- From Annex:
 - The main focus of the project is the improvement and refinement of theoretical predictions for Higgs boson production and decay, as well as the development of corresponding tools aiming at a reduction of the theoretical uncertainties.
 - This corresponds to the Task 2.1: Improved predictions for Standard Model-like Higgs scenarios
 - improvement of existing results by calculating perturbative corrections at NNLO and beyond
 - study the residual theoretical uncertainties and the possible impact of physics beyond the SM
 - development of fast and user-friendly tools including these results
- I am working on inclusion of dimension 6 operators (i.e. Beyond Standard Model effects via the Effective Field Theory approach) into predictions of p_T spectra of Higgs particles
 - BSM via EFT is a theoretically consistent way to parametrise deviations from the SM which are expected to be measured during the LHC run 2 and beyond
 - Choice of relevant dimension 6 operators
 - Inclusion of QCD corrections
 - Implementation done in HqT code: popular tool for the calculation of the state-of-art Higgs particle p_T spectra
- Due to the inclusion of BSM effects via EFT the project relates to:
 - Task 2.2: Improved predictions for non-standard electroweak symmetry breaking scenarios
- And my work may be useful for:
 - Task 1.1: Extraction of model-independent results from data
 - Task 1.2: Measurement of Higgs properties



Milestones of the Project

- The project corresponds to the Milestones:
 - M2.1.1 Specialised codes for the SM-like Higgs boson scenario
 - M2.1.2 Better control of theoretical uncertainties for the SM-like Higgs boson scenario
 - M1.4.1 Review of the current state and future directions in Higgs boson physics
- But due to its BSM character it relates also to:
 - M2.2.2 Precision calculations of non-standard Higgs boson scenarios
 - M2.2.3 Standardised description for non-standard Higgs boson interactions
 - M2.2.4 Interpretation of experimental data in the light of M2.2.3
- The EFT part of the project is related to the project at YRM in the BSM/EFT WG together with ESRs 5, 9, 11 and 12, working also on BSM physics
- I work also on a side project with collaborators from University of Warsaw and Technical University Dresden in which we investigate a specific BSM scenario: Inert Doublet Model
- It corresponds to:
 - Task 1.3: Interpretation of experimental results in different models
 - Milestone 1.3.1 Constraints on physics beyond the SM, distinction between different models



EFT project on Higgs p_T spectrum

- We have implemented the dimension 6 operators - modifications of Yukawa coupling and ggh-point coupling into the HqT programme
- Inclusion of full quark mass dependence
- The implementation includes NLO QCD corrections
- Also resummation, allowing calculations at low p_T , is included at NLL level

IDM project

- We extracted the allowed parameter space of the model taking into account all theoretical and experimental (collider and astrophysical) bounds
- We also provided benchmarks which may be useful in searches at the LHC



Publications and Conference Attendance

Publications

- From IDM project one full-length paper (arXiv:1508.01671) and two conference proceedings (arXiv:1505.04734, 1510.04159)
- From EFT - p_T project proceedings and peer-reviewed paper in preparation

Conferences and Workshops

- Zurich Phenomenology Workshop - Flavour of New Physics (ZPW2015) in January 2015
- First HiggsTools Young Researchers Meeting in Lumley Castle, February 2015
- First HiggsTools Annual Meeting in Freiburg, April 2015
 - talk on my project
- European Physical Society Conference on High Energy Physics in Wien, July 2015
 - talk on my project
 - poster on IDM project
- Workshop Higgs Hunting in Orsay, July 2015
 - talk on my project
- ETH/PSI/UZH PhD Seminar in PSI, August 2015
 - talk on my project



Schools

- Zuoz Summer School organised by PSI in August 2014: More than Higgs - Effective Theories for Particle Physics
- GGI Lectures on Theory of Fundamental Interactions in January 2015: followed courses in Collider Physics, Neutrino Physics, Particle Physics and the structure of 4D RG flows and partially Cosmology
- HiggsTools Summer School in June 2015

Courses followed at ETH/UZH

- Physics of Electroweak Symmetry Breaking (Fall Semester 2014)
- Advanced topics in Quantum Field Theory (Spring Semester 2015)
- Standard Model of Electroweak and Strong Interactions (Spring Semester 2015)
- I also follow relevant seminars and colloquia at ETH, UZH and PSI

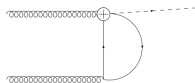


Hard Technical Points: Chromomagnetic operator

- We have included three new dimension 6 operators relevant for the Higgs boson production
 - ggH point coupling
 - top yukawa modification
 - bottom yukawa modification



- There is one more dim 6 operator which may be relevant: chromomagnetic operator



- It has a different structure than previous operators, one may not "reuse" SM calculations
- It is constrained by the previous tt production measurements at the TeVatron
- We think it will not have big impact → study at LO
- Problem would arise if the effects will be sizeable, then: the QCD corrections need to be calculated (not known) and included in spectra calculations

Hard Technical Points: What if LHC run 2 finds new physics?

- Quite improbable from theoretical perspective: no strong hints that BSM physics should be around the corner
- We can always extend the framework of BSM via EFT by including new fields into dim 6 operators
- Still work done is useful, i.e. we implemented the matrix element calculations into HqT



- Preparation to release code for the calculation of Higgs particle p_T spectra with inclusion of dim 6 operators available at NLO+NLL level
- Preparation of paper based on the above work
- Inclusion of the QCD corrections and resummation at NNLO+NNLL, i.e. the state-of-art for SM calculations

- Depending on the timing and opportunities, continuing side project on IDM
- Possible collaboration within HiggsTools on matching the BSM models onto SMEFT (dim 6 operators), starting at YRM

Outlook: Secondments

- Private Sector Secondment in Maplesoft (Waterloo, Canada)
 - Planned for April-June 2016
 - I will work on physics package of Maple programme
 - Some formalities already taken care of (contract with AIESEC, application for work permit, ...)
- Academic Secondments at UZH and PSI:
 - I am enrolled as a PhD student at UZH, I work there most of the time
 - I am in PSI one day per week
- Academic Secondments:
 - ALU-FR (1 month): depending on the development of the project starting at YRM, maybe even soon. If not, probably during last year of the project.
 - DFTTO (2 months): planned for the last year of the project.

- During the last year of project: applications for the post doc positions
 - Having experience to collaborate with important researchers in the field should be helpful
 - Possibility to work in other institutions, not only our University
 - Also the possibility of creating the network to collaborate on important issues in particle (Higgs) physics
- Possibilities for future career in private sector:
 - Experience with Maplesoft will be very important, both for CV and also my attitude