Annual Report

Funding Programme:	Helmholtz Young Investigators Groups
Project ID No.:	VH-NG-701
Project Title:	Higgs Physics with Photons at the ATLAS Experiment
Group Leader:	Kerstin Tackmann, PhD
Helmholtz Centre:	Deutsches Elektronen-Synchrotron DESY
Participating University:	Universität Hamburg
Report Period (=Calendar Year):	01/2015-12/2015

1) Group Structure

Please report briefly on the structure and personnel development of your group.

During 2015, the group consisted of the following members

Kerstin Tackmann	group leader	
Elisabeth Petit	postdoc	until September 30, 2015
Nicholas Styles	postdoc	October 1, 2015 – November 30, 2015
Yanping Huang	partially associated postdoc	associated to SFB 676
Jike Wang	partially associated postdoc	until March 31, 2015
Eda Yıldırım	graduate student	
Christopher Hengler	graduate student	
Marco Filipuzzi	graduate student	
Martin Bessner	graduate student	
Nils Flaschel	graduate student	
Daniel Rauch	graduate student	since June 1, 2015
Phillip Hamnett	associated graduate student	
Cong Peng	joint graduate student with IHEP Beijing	since September 10, 2015
Früd Braren	Masters student	until April 24, 2015

During 2015, the personnel developed according to the table above. Elisabeth Petit left DESY at the end of September to start a permanent position at LPSC Grenoble. Nicholas Styles joined the YIG as a postdoc for two months, before starting a permanent position in the DESY ATLAS group. He continues to collaborate with the YIG. With the start of a new DESY ATLAS team focusing on beyond Standard Model physics, Jike Wang, a DESY fellow, moved into the new team in 2015. Daniel Rauch joined the YIG as a new graduate student. Cong Peng, a graduate student at IHEP in Beijing, received a scholarship from the China Scholarship Council that allows him to stay at DESY for 18 months, and is a joint student at IHEP and DESY since September 2015. Früd Braren worked with the YIG for his Masters thesis at the University of Hamburg until April.

The work of the group falls into two categories: data analysis at the ATLAS experiment at CERN studying final states containing photons and performance of the photon reconstruction and identification, and studying radiation damange in silicon detectors and new detector

cooling concepts. During 2015, Elisabeth Petit, Nicholas Styles, Yanping Huang, Jike Wang, Christopher Hengler, Marco Filipuzzi, Martin Bessner, Phillip Hamnett, Cong Peng and Früd Braren were involved in the first topic. Eda Yıldırım and Nils Flaschel were involved in the second topic. Kerstin Tackmann, as the group leader, was involved in the work of both categories. Daniel Rauch worked on his authorship task in the area of event generators to qualify for authorship on ATLAS publications.

2) Network

Please describe how you / your research group are integrated within the Helmholtz Centre and the partner university (e.g. as member of committees).

The YIG is a well-integrated part of the ATLAS group at DESY. The analysis activities, which focused on Higgs and Standard Model measurements during 2015, form one of the four main data analysis topics of the DESY ATLAS group. The work on radiation damage in silicon detectors and detector cooling is well-integrated into the silicon detector upgrade acitivities in the DESY ATLAS group. In addition, the YIG has actively taken part in joined discussion meetings of the DESY ATLAS, CMS and theory groups on LHC physics. Kerstin Tackmann serves on the Scientific Committee of DESY since May 2014.

During 2015, Kerstin Tackmann supervised one Masters student at the University of Hamburg.

The YIG is also well-integrated into the ATLAS collaboration, and in particular in the subgroup measuring the Higgs boson properties in the diphoton final state ($H \rightarrow \gamma\gamma$ group), for which Elisabeth Petit served as co-convener since April 2015. It is equally well integrated into the group dedicated to electron and photon combined performance (e/γ), for which Elisabeth Petit served as a coordinator of photon identification development and efficiency measurements until the end of March 2015, and for which Kerstin Tackmann served as co-convener until the end of September 2015. It also contributes to the Standard Model photon+jets subgroup.

3) Satisfaction

How satisfied are you with the general working conditions provided by the Helmholtz Centre / partner university? Is there anything that meets your criticism?

I am very satisfied with the working conditions at DESY and with the integration of the YIG into the DESY ATLAS group, which allows for a very autonomous operation of the YIG within the group, but for a very good collaboration at the same time.

I am also satisfied with the rights to supervise graduate students, as well as Bachelor and Masters students and the right to teach at the university. Finding a second supervisor for each graduate student among the professors of the University of Hamburg, as required, was successful in all cases.

4) Scientific Progress / Milestones

How has your work plan progressed? Which important milestones could be achieved during the report period? Is the progress of your work in accordance with original planning or has the work plan been changed?

The workplan of the YIG foresaw two areas of activity, photon and Higgs boson analysis, and silicon detectors. During 2015, various aspects of both activities were carried out.

After the discovery of a Higgs boson by the ATLAS and CMS experiments in 2012, the focus of the Higgs boson studies was the study of the properties of the new particle, to which the YIG made significant contributions. In addition, a measurement of diphoton production in pp collisions was part of the program, along with smaller activities related to searches for physics beyond the Standard Model and MC event generators.The YIG focused on several areas:

- Higgs boson fiducial cross section measurement in $H \rightarrow \gamma\gamma$ decays with 7 and 13 TeV data: signal and background parametrization and bias studies and signal extraction

(Yanping Huang), evaluation of correction factors and systematic uncertainties (Cong Peng, Yanping Huang), performance study for the primary vertex selection using Z→ee decays (Nicholas Styles), editor of internal documentation (Cong Peng)

- preparation of differential cross section measurements in H→γγ decays with 13 TeV data: unfolding studies (Cong Peng, Yanping Huang)
- differential cross section measurements in H→γγ decays with 8 TeV data: study of inclusive event shapes (Marco Filipuzzi, Früd Braren), measurement and study of the diphoton transverse momentum spectrum (Christopher Hengler)
- development of a vector-boson fusion production selection based on inclusive event shapes (Früd Braren, Marco Filipuzzi)
- preparation of Higgs boson coupling studies in H→γγ with 13 TeV data: optimization of VH selection for hadronic V decays (Cong Peng, Yanping Huang), coordination of the analysis within ATLAS as analysis contact (Nicholas Styles)
- search for RS gravitons decaying into two photons with 2015 data: studies of event selection and reducible backgrounds (Elisabeth Petit, Phillip Hamnett)
- preparations for the HH→bbγγ search with 13 TeV data (Jike Wang, continued as part of the DESY ATLAS BSM team)
- measurement of diphoton production cross sections in events with jets in 8 TeV data (Martin Bessner, Elisabeth Petit)
- co-convening of the ATLAS electron and photon combined performance group (including electron and photon reconstruction, identification, calibration, ...) (Kerstin Tackmann)
- coordination of the ATLAS photon identification subgroup (Elisabeth Petit)
- summary paper about photon identification in Run1 (Elisabeth Petit)
- development of the photon identification for 2015 data-taking conditions (Phillip Hamnett, Martin Bessner, Elisabeth Petit)
- study of photon conversion reconstruction performance using longitudinal shower shapes for 2015 data (Cong Peng, Yanping Huang)
- MC generators: validation of tt production with Herwig++ and integration of MadGraph5_aMC@NLO into the ATLAS framework (Daniel Rauch in collaboration with Judith Katzy)

Also for the second activity, silicon detectors, the YIG focused on several aspects, following the original planning

- analysis of test beam measurements for Lorentz angle and charge collection efficiency studies in silicon microstrip sensors for 12 different test sensors, 10 of which were irradiated with neutrons at 6 different fluences (before and partially after controlled annealing) (Eda Yıldırım in collaboration with Ingrid-Maria Gregor and Claus Kleinworth)
- study of cross talk in the simulation of the ATLAS silicon microstrip detector (Nils Flaschel)
- thermal and mechanical studies of a microchannel cooling prototype developed in collaboration with CNM (Spain) and fluid dynamics and temperature simulations (Nils Flaschel in collaboration with Ingrid-Maria Gregor, Sergio Diez Cornell and Andreas Mussgiller)

5) Financial Plan / Time Schedule

Can you comply with the financial plan and time schedule or do you see a need for adjustment?

With all positions filled during most of the time, and three additional graduate students in the YIG (compared to the original planning), the cost for personnel was higher than originally envisioned. The higher personnel costs were offset by lower travel costs (e.g. because no member of the YIG was present at CERN full-time for most of the year), and fewer needed investments from the original YIG budget.

A substantial amount of the additional funds for investments could be used during 2015 and the remaining funds are foreseen to be used during 2016.

After the discovery of the new particle in summer 2012, it was timely to contribute to its property measurements in the H→γγ decay channel right after the discovery and hence the analysis activities of the YIG were focused on this. These measurements were finalized and published in summer 2014. During the second part of 2014, the focus shifted to the preparations for the 2015 data, and the measurement of the diphoton production cross section in events with jets in the 2012 data, an activity that had not been covered within ATLAS before. These topics were continued during 2015, moving from the preparation for 2015 to the analysis of 2015 data.

6) Status

Do you hold a joint Junior Professorship or a W2/W3 Professorship? Do you aim for such a position? What is the status of your negotiations in this respect?

Unfortunately, the University of Hamburg does not offer Junior Professorships for YIG leaders.

7) Teaching Activities of the Group Leader

During 2015, I did not take any teaching responsibilities at the University of Hamburg since it was difficult to combine this with the 50% presence at CERN that I was maintaining for my co-convenership.

Nevertheless, I supervised one Masters student from the University of Hamburg, who wrote his Masters thesis in my YIG.

8) Publications of the Group

Listed are those publications, conference notes, and proceedings to which members of the YIG contributed significantly. In addition, Kerstin Tackmann, Elisabeth Petit, Nicholas Styles, Yanping Huang, Jike Wang, Eda Yıldırım, Christopher Hengler, Marco Filipuzzi, Martin Bessner, and Philipp Hamnett were authors of all publications and conference notes of the ATLAS collaboration. Nils Flaschel was granted authorship during 2015.

- HVMUX, the High Voltage Multiplexing for the ATLAS Tracker Upgrade. E. G. Villani et al., JINST 10 (2015) C010141.
- Higgs boson couplings to bosons with the ATLAS detector: run 1 legacy. Elisabeth Petit on behalf of the ATLAS Collaboration. ATL-PHYS-PROC-2015-017. Il Nuovo Cimento C 38 04.
- Electron identification measurements in ATLAS using √s=13 TeV data with 50 ns bunch spacing. The ATLAS Collaboration. ATL-PHYS-PUB-2015-041.
- Photon and photon+jet production measurements with the ATLAS detector. Martin Bessner on behalf of the ATLAS Collaboration. ATL-PHYS-PROC-2015-094. PoS(EPS-HEP2015)484.
- Measurement of the Higgs boson production cross section at 7, 8 and 13 TeV center-of-mass energies in the H→γγ channel with the ATLAS detector. The ATLAS Collaboration. ATLAS-CONF-2015-060.
- Search for resonances decaying to photon pairs in 3.2 fb^{-1} of *pp* collisions at √s=13 TeV with the ATLAS detector. The ATLAS Collaboration. ATLAS-CONF-2015-081.

9) External Funding

Kerstin Tackmann was awarded an ERC Starting Grant for the measurement and interpretation of differential cross sections in the H→γγ and H→4l decay channels. The project will start in May 2016.

10) Patent Applications *No. of pending/granted patents*
No patent applications were submitted during 2015.
11) Awards received by Group Members / Professorship Appointments offered to Group Leader
No awards were received by any group member during 2015. Kerstin Tackmann did not apply for professorship positions.