

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):	01/2012-12/2012

1) Group Structure

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

During 2012, the group consisted of the following members

Kerstin Tackmann	group leader	
Marcos Jimenez Belenguer	postdoc	
Martin Goebel	associated postdoc	until May 31, 2012
Sergei Gleyzer	partially associated postdoc	since May 15, 2012
Eda Yıldırım	graduate student	
Christopher Hengler	graduate student	since January 1, 2012
Marco Filipuzzi	graduate student	since March 16, 2012
Früd Braren	Bachelor student	until June 19, 2012

During 2012, the personnel structure of the group developed according to the table above. Martin Goebel left DESY to start a position outside of research. At about the same time, Sergei Gleyzer joined DESY as a fellow and joined the YIG for a fraction of his research time. Christopher Hengler, whose thesis advisor had left DESY during 2011, joined at the beginning of his second year as a graduate student. Marco Filipuzzi was hired as a new graduate student and fills the position at the university of Hamburg. Finally, Früd Braren successfully defended his Bachelor thesis in June and continues his Masters studies at the university of Hamburg.

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 damage in silicon detectors and operation of the ATLAS silicon microstrip detector. During 2011, Marcos Jimenez Belenguer, Martin Goebel, Sergei Gleyzer, Christopher Hengler and Früd Braren were involved in the first topic. Eda Yıldırım and Marco Filipuzzi concentrated on the second topic. Kerstin Tackmann, as the group leader, was involved in the work of both categories. During July to September, two DESY summer students, Sinan Kefeli and Eleni Skorda, worked with the YIG on summer projects.

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 the Higgs search and measurements during 2012, are one of the four main data

analysis topics of the DESY ATLAS group. The work on radiation damage in silicon detectors is well-integrated into the silicon detector upgrade activities in the DESY ATLAS group. Similarly, the contribution to the operation of the ATLAS silicon microstrip detector is an integral part of DESY's contribution to this detector subsystem. In addition, the YIG has actively taken part in joined discussion meetings of the ATLAS, CMS and theory groups on LHC physics.

During 2012, the group leader participated in the supervision of Bachelor students and in teaching at the university of Hamburg.

The YIG is also well-integrated into the ATLAS collaboration, and in particular in the subgroup searching for and measuring the Higgs boson properties in the diphoton final state ($H \rightarrow \gamma\gamma$ group), for which Kerstin Tackmann serves as a co-convenor since October 2012. It is equally well integrated into the group for electron and photon reconstruction (e/γ group), for which Marcos Jimenez Belenguer has been serving as a coordinator of photon efficiency measurements. Kerstin Tackmann and Marcos Jimenez Belenguer also served on two and one, respectively, internal editorial boards for the review of publications of the collaboration.

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, has in some cases proven a bit cumbersome.

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 physics, and silicon detectors. During 2012, various aspects of both activities were carried out.

The remarkable performance of the LHC during 2011 and 2012 and the large amount of data collected by the ATLAS experiment made 2012 the year of the Higgs discovery. The YIG concentrated on the Higgs search and measurements and contributed significantly to the results published by the ATLAS collaboration, following the original plan. The YIG focused on several areas

- coordination and co-convening of the $H \rightarrow \gamma\gamma$ analysis of the ATLAS collaboration since October 2012 (Kerstin Tackmann)
- measurement of the photon identification efficiency using electrons from Z boson decays, and statistical combination of the results with those obtained using complementary methods (Marcos Jimenez Belenguer, Christopher Hengler, Sergei Gleyzer, Kerstin Tackmann). Marcos Jimenez Belenguer also served as coordinator of the photon identification measurements within the ATLAS collaboration and as an editor of the conference note on photon identification measurements in the 2011 data released in fall 2012 and of the corresponding internal documentation.
- preparation of the reconstruction of converted photons for the data-taking conditions expected in 2012 and integration of dedicated electron fits for the central ATLAS reconstruction, which was used to process the 2012 data (Kerstin Tackmann)

- editing of the conference note for the $H \rightarrow \gamma\gamma$ results presented at the ICHEP conference in July 2012, and of the collaboration internal main documentation (Kerstin Tackmann)
- editing of the collaboration internal documentation for the $H \rightarrow \gamma\gamma$ results presented at a CERN seminar in December 2012 (Marcos Jimenez Belenguer)
- search for a potential decay $H \rightarrow a_0 a_0 \rightarrow \gamma\gamma\gamma\gamma$ with a light a_0 , which is predicted in multiple models beyond the Standard Model, based on the 2011 data. This included the editing of the internal documentation and the conference note contributed to the ICHEP conference in July 2012 (Früd Braren, Marcos Jimenez Belenguer, Martin Goebel, Kerstin Tackmann)
- measurement of the radiation length of the material in the tracking detector using photon conversions, which will contribute to the understanding of the photon energy scale (Kerstin Tackmann)
- study of a spin measurement in $H \rightarrow \gamma\gamma$ (Sinan Kefeli, Sergei Gleyzer, Kerstin Tackmann)
- investigation of the properties of photons in the $H \rightarrow \gamma\gamma$ signal region (Eleni Skorda, Marcos Jimenez Belenguer, Christopher Hengler)

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

- preparation of a test beam setup for the measurement of Lorentz angles in irradiated silicon sensors. A first preliminary beam test was carried out to test the first parts of the setup including analysis of the data, and the final mechanical setup was developed (Eda Yıldırım, Kerstin Tackmann in collaboration with Ingrid-Maria Gregor and Carsten Muhl)
- implementation of effects of radiation damage in silicon (charge trapping) in the simulation of the ATLAS silicon microstrip detector (Marco Filipuzzi, Kerstin Tackmann in collaboration with Peter Vankov)
- monitoring of the ATLAS silicon microstrip detector (Marco Filipuzzi)
- preparation of the study of micro channel cooling for silicon detectors (additional investment proposal) (Kerstin Tackmann in collaboration with Ingrid-Maria Gregor 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?

Since one graduate student position could not be filled during 2012, less funds than planned were used for graduate student salaries, resulting in some surplus, which was used to support an associated postdoc (Martin Goebel). Less funds than originally planned were used for investments. For the core activities of the YIG, fewer investments were needed during 2012. For the additional investment activity on the study of micro channel cooling, only the first investments could be made in 2012 since the associated graduate student position remained open (no suitable candidate was found). In both cases, the majority of the surplus should be used for investments needed in 2013.

Since it was very timely to contribute to the $H \rightarrow \gamma\gamma$ search and measurements during 2012, the study of Standard Model photon production was left for the future (expected to start in 2014). This allows the YIG to significantly participate in one of the highest profile topics during 2012 and 2013, and to contribute to the longer-term photon studies during the second year of the LHC shutdown, when this area will still offer interesting tasks despite using data taken in 2011 and 2012.

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. Currently, I am not aiming for such a position.

7) Teaching Activities of the Group Leader

I contributed to the teaching at the university of Hamburg. During all three semesters (winter 2011/2012, summer 2012 and winter 2012/2013) I taught the Bachelor student seminar "Particle and Astroparticle Physics" together with colleagues from the university.

In addition, I gave two lectures about "Physics at the LHC" at the Monte Carlo school of the Helmholtz Alliance at DESY in March 2012, and two lectures about "Electroweak and Higgs Physics" as part of the DESY summer student program.

8) Publications of the Group

Listed are those publications, conference notes and proceedings to which a member of the YIG contributed significantly and which were published while they worked for the YIG. In addition, Kerstin Tackmann, Marcos Jimenez Belenguer and Martin Goebel were authors of all publications and conference notes of the ATLAS collaboration.

- Search for the Standard Model Higgs boson in the diphoton decay channel with 4.9 fb^{-1} of pp collisions at $\sqrt{s} = 7 \text{ TeV}$ with ATLAS. The ATLAS Collaboration. Phys. Rev. Lett. 108, 111803 (2012).
- Improved electron reconstruction in ATLAS using the Gaussian Sum Filter-based model for bremsstrahlung. The ATLAS Collaboration. ATLAS-CONF-2012-047.
- Search for a Higgs boson decaying to four photons through light CP-odd scalar coupling using 4.9 fb^{-1} of $\sqrt{s} = 7 \text{ TeV}$ pp collision data taken with the ATLAS detector at the LHC. The ATLAS Collaboration. ATLAS-CONF-2012-079.
- Observation of an excess of events in the search for the Standard Model Higgs boson in the $\gamma\gamma$ channel with the ATLAS detector. The ATLAS Collaboration. ATLAS-CONF-2012-091.
- Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC. The ATLAS Collaboration. Phys. Lett B 716 (2012).
- Measurements of the photon identification efficiency with the ATLAS detector using 4.9 fb^{-1} of pp collision data collected in 2011. The ATLAS Collaboration. ATLAS-CONF-2012-123.
- Search for the Higgs boson in the diphoton decay channel with the ATLAS detector. Kerstin Tackmann on behalf of the ATLAS Collaboration. ATL-PHYS-PROC-2012-272.
- Observation and study of the Higgs boson candidate in the two photon decay channel with the ATLAS detector at the LHC. The ATLAS Collaboration. ATLAS-CONF-2012-168.

9) External Funding

No external funding was acquired during 2012, but additional funding for investments (100000 Euros) was obtained from the Helmholtz Gemeinschaft, through a proposal following the call opened in January 2012.

10) Patent Applications

No. of pending/granted patents

No patent applications were submitted during 2012.

11) Awards received by Group Members / Professorship Appointments offered to Group Leader

No awards were received by the group members during 2012. The group leader was not offered any professorship positions.