



Universität Hamburg

## Helmholtz-Hochschul-Nachwuchsgruppe VH-NG-206

"R&D studies for new photo-detectors and their integration in HEP detectors"

### Activity Report 2006

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#### Group Members of the Helmholtz-Hochschul-Nachwuchsgruppe (2006)

Group Leader:	Dr. Erika Garutti	DESY
Postdoctoral Fellow:	Dr. Niels Meyer	DESY
Graduate Students:	Nicola D'Ascenzo	DESY
	Nanda Wattimena	DESY

#### Associate Group Members from the partner institutes (2006)

University partners:	Prof. Dr. Rolf-Dieter Heuer	Univ. Hamburg
	Prof. Dr. Hans-Christian Schultz-Coulon	Univ. Heidelberg
	Prof. Dr. Tohru Takeshita	Univ. Shinshu
Graduate Students:	Marius Groll	Univ. Hamburg
	Saori Ito	Univ. Shinshu

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The Young Investigator Group VH-NG-206 has started its activity on the 1st of March 2006 with the group leader (Dr. E. Garutti) and one PhD student (N. D'Ascenzo). In April the postdoctoral fellow Dr. N. Meyer has joined the group followed by another PhD student N. Wattimena). Two students from the university partners work in collaboration with the group, M. Groll (supervised by Prof. R.-D. Heuer) and S. Ito (supervised by Prof. T. Takeshita).

#### Main commitments of the group:

The CALICE collaboration

The group is member of the CALICE (Calorimeter for a Linear Collider Experiment) collaboration, together with 38 institutes from 13 countries, whose main objective is the development of the next generation of calorimeters for future HEP detectors, based on innovative technologies to allow unprecedented granularity and segmentation of all detector components.

Among the detectors investigated by the collaboration, a highly granular hadronic calorimeter prototype has been developed based on a sampling structure with scintillating tiles (of smallest size  $3 \times 3 \times 0.5 \text{ mm}^3$ ) individually readout by innovative silicon-based photo-detectors (Silicon-Photomultiplier (SiPM), from MEPHY/ PULSAR) mounted directly on each tile. Due to the green sensitivity of the photo-detector a wavelength shifting fiber is used to couple the scintillation light to the SiPM.

The calorimeter prototype equipped with more than 5000 SiPM has been tested this

summer at the CERN SPS test beam. The operation of the detector, mainly driven by the photo-detectors, has proved to fulfill expectations and the analysis of the physics data collected is at present in full swing. In the year 2007 the CERN test beam will be repeated with fully commissioned detectors. Test beams at Fermilab, Chicago, will follow in year 2008.

#### The ALPS experiment

The group is also involved in the ALPS (Axion-like Particle Search) experiment, a joint-venture of DESY, Laserzentrum Hannover e.V. and Hamburger Sternwarte. The experiment aims at the exploration of possible axion-induced signals reported by the PVLAS collaboration. Core elements of the setup are a high power laser, a spare HERA dipole magnet and a semi-conductor based detector with single photon sensitivity, the main motivation for our group to join. ALPS has been approved recently by the DESY directorate and is currently under construction.

#### **A short description of the main activities of the group in the year 2006:**

##### Commissioning of the hadronic calorimeter prototype

The group main activity during its first year has been the preparation for the test of a hadronic calorimeter prototype for the ILC at the CERN test beam. The leader of the group (Dr. E. Garutti) has been appointed as one of the two run coordinators for the four months of July - November. All the group members have taken active part to the CERN test beam. They have actively contributed to the detector commissioning and the data taking, as well as to the first level analysis and data quality checks.

At the end of the CERN test beam the group has concentrated on all aspects of data analysis: calorimeter calibration, muon response, electromagnetic response and first look into hadronic shower developments.

As recognized by the entire CALICE collaboration (of which the group is part) the CERN test beam has been a great success with more than 95% detector up-time and about 70 millions event stored to disk.

The ongoing analysis of the data will lead to several publications in the coming years.

##### Research and study of new photo-detectors

In parallel to the main calorimeter activities, the group has established a laboratory set-up for R&D studies of Silicon-Photomultipliers. A new Geiger-mode silicon photo-detector produced by Hamamatsu (Multi-Pixel Photon-Counter) has been characterized. This new photo-detector offers a much better sensitivity to blue light with respect to the one utilized in the hadronic calorimeter prototype. Studies on direct and indirect (via wavelength shifting fiber) coupling of these new devices to scintillator tiles are ready for publication.

The laboratory has also served for didactics. One diploma student and several groups of practicum students from high school and university have learned to perform accurate measurements of photon counting, and of photo-detector characterization. The pedagogical aspect of this project has proved very important and in the future the group plans to establish a permanent laboratory course for the university of Hamburg, if funds will be sufficient to improve the quality of the electronics in the laboratory.

## Optimization of the integration of photo-detectors in calorimeter readout

Following the very positive experience of the first hadronic calorimeter prototype with SiPM readout, it has been decided to build a small electromagnetic calorimeter prototype with the same technology. The challenge is to decrease the granularity of calorimeter cells by a factor of  $\sim 3$ , and the cell thickness by a factor  $3/5$ . Hamamatsu Silicon-Photomultipliers (MPPC) have been used in this project. This gives the advantage of a possible direct coupling of the photo-detector to a scintillator tile.

The prototype of electromagnetic calorimeter has been entirely build in Japan. Our university partners from Shinshu University play a key role in this project. The detector will be tested at DESY during Feb.-Mar. 2007 using the same readout electronics employed in the hadronic calorimeter prototype. Our group is responsible for the integration of the detector in the readout chain and for the support at the DESY test beam.

## New fields of applications for the photo-detectors

Compared to the projects described above, ALPS is only a minor activity of the group with Dr. N. Meyer devoting approximately 20% of his time. Nevertheless, important contributions could be made to the design of the experiment and the editing process of the successful proposal. During the ongoing construction phase, main focus of our contribution is put on preparative detector studies and software developments for simulation and analysis.

### List of Publications

- 1) N. D'Ascenzo, E. Garutti, M. Groll, ..., N. Wattimena, et al. *CALICE scintillator HCAL commissioning experience and test beam program*, LC-DET-2006-009.
- 2) E. Garutti, M. Groll, et al. *Dedicated very front-end electronics for an ILC prototype hadronic calorimeter with SiPM readout*, LC-DET-2006-007.
- 3) E. Garutti *CALICE scintillator HCAL commissioning experience and test beam program*, Proceeding to the conference CALOR'06, Chicago, 5-9 Jun 2006.
- 4) N. Meyer et al. *Production and Detection of Assion-like particles in a HERA dipole magnet*, Letter of Intent for the ALPS experiment, DESY-07-014, hep-ex/0702023.