

Zwischenbericht (Sachbericht)

Fördermaßnahme:	Helmholtz-(Hochschul-)Nachwuchsgruppen
Förder-Nr.:	VH-NG-206
Titel des Vorhabens:	R&D Studies for New Photo Detectors and their Integration in HEP Detectors
Nachwuchsgruppenleiter/in:	Dr. Erika Garutti
Helmholtz-Zentrum:	Deutsches Elektronen-Synchrotron DESY
Beteiligte Hochschulen:	Universität Hamburg; University of Shinshu, Japan; Universität Heidelberg, Kirchhoff-Institut für Physik
Berichtszeitraum (Förderungszeitraum):	01.01.2008 bis 31.12.2008



Universität Hamburg

Helmholtz-Hochschul-Nachwuchsgruppe VH-NG-206

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

Activity Report 2008

Group Members of the Helmholtz-Hochschul-Nachwuchsgruppe (2008)

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

Associate Group Members from the partner institutes (2008)

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:	Nils Feege	Univ. Hamburg
	Alexander Kaplan	Univ. Heidelberg
	Wei Shen	Univ. Heidelberg
	Alexander Tadday	Univ. Heidelberg
Diploma Student:	Sebastian Richter	Univ. Hamburg

The Young Investigator Group VH-NG-206 has started its activity on the 1st of March 2006. During year 2008 three new PhD student have joined the group from the university partners of Hamburg and Heidelberg, and from DESY.

The group activity is in full swing, and all the proposed topics are well covered.

Main commitments of the group:

A list of the group main commitments can be found in the yearly report of 2007.

A short description of the main activities of the group in the year 2008:

Commissioning of the hadronic calorimeter prototype

The year 2008 has seen the installation of the AHCAL calorimeter prototype at Fermilab, Chicago, for the start of a new campaign of test beam at the Meson Test Beam Facility (MTBF). After a successful commissioning time in April the entire CALICE experiment was operational and the collaboration has taken data for three beam periods of approximately one month each. The members of the group have played a key role in the

installation, commissioning and running of the experiment.

In the third period the Silicon-Tungsten based electromagnetic calorimeter has been replaced by a Scintillator-Tungsten based one provided by the Japanese group members of the collaboration. Our group has supported the installation and provided expertise for the integration of the new detector.

E. Garutti has taken an active role in support of the run coordination as in the previous years. N. Meyer was appointed software coordinator of the CALICE collaboration and has supervised the software aspects of installation and operation. A. Kaplan and N. Feege have acted as AHCAL experts on-call during the test beam periods. All group members have taken shifts in Fermilab and in the remote control room at DESY.

Remote control room for ILC test experiments

Thanks to the HGF Sonderförderung SO-NG-064 the group has made a significant contribution to the realization of a remote control room, located at DESY, for the control of the ILC test beam activities around the world. The new control room has been equipped and was functional by the start of the Fermilab campaign. A fraction of the shifts have been taken remotely from DESY.

The control room ensures the capability to run the experiment remotely with the help of highly sophisticated tools like high-resolution steerable cameras and a web-accessible oscilloscope. The easy exchange of information with the local crew in Fermilab is ensured by a high quality audio conferencing system, which acts as an open window between the two control rooms.

This project had a very positive impact on the work of the collaboration, and most general on the ILC R&D projects. An interesting press article on this project can be found at:

http://www.linearcollider.org/newsline/readmore_20080605_atw.html

Software development and analysis of CALICE data

The group is active in the development of software tools for the calibration and in the analysis of the test beam data collected with the AHCAL prototype.

N. Meyer has accepted the role of software coordinator for the CALICE collaboration and is driving the software development effort. The whole group is involved in data analysis. The following topics are covered by group members: muon calibration and muon physics in the AHCAL, temperature correction of the detector response, electromagnetic shower studies, validation of MC models for hadronic showers.

Two diploma students working within the group have finalized their theses work on analysis of CALICE data during 2008.

Research and study of new photo-detectors

A new set-up has been established for the precise characterization of SiPM devices at Heidelberg. The set-up allows measurements of dark-rate, of gain and most important of photo-detection efficiency. A high precision movable support and a highly collimated beam of monochromatized light allow the scan of each pixel in a SiPM with micrometer resolution. This offers a sharp view on the detector geometry as well as the possibility to investigate surface defects. New photo-detectors both from Hamamatsu and from SenseL

have been tested in this set-up, as well as the SiPM from MEPHI/Pulsar used already in the CALICE calorimeter prototype.

The PET experiment

In the DESY laboratory set-up for PET tests of the readout of inorganic scintillators crystals via the new silicon photo-detector produced by Hamamatsu (MPPC) have been performed. It has been demonstrated that MPPC devices are very suitable for this type of application. The good energy resolution (12% FWHM) allows to distinguish between Compton and photo-electric events, allowing to reject scattered events with high efficiency as it is necessary for PET application. The achieved time resolution of 460 ps FWHM is important to reduce the number of random coincidences and to use time-of-flight information to considerably improve the signal to background ratio of the reconstructed images.

The very good performance of the gamma-detectors motivated the next step toward building a gamma camera consisting of a matrix of MPPC devices and scintillator crystals. The construction and test of the gamma camera is planned for the year 2009.

With funds from the HGF Sonderförderung SO-NG-064 100 LFS crystals have been bought and tested. The homogeneity of the crystal production is satisfactory.

The first studies on the properties of the ASIC chip which could be used for the multi-channel readout of the camera are ongoing. The Heidelberg group has proposed to develop an ad-hoc designed chip for PET application. The Heidelberg group is also contributing with engineering support, providing the mechanical structure and the motor-driven rotation system for the camera.

The photo-detector needed for the matrix readout have been ordered and are also financed through the Sonderförderung SO-NG-064.

Simulation studies are ongoing at DESY to fix the main parameters of the camera and determine the expected spatial resolution.

List of Publications

- 1) E. Garutti, A. Kaplan, N. Meyer, et al. *Fast and reasonable Installation, Experience and Acceptance of a Remote Control Room*, Nov 2008., e-Print: arXiv:0811.3228.
- 2) By CALICE Collaboration. *Design and Electronics Commissioning of the Physics Prototype of a Si-W Electromagnetic Calorimeter for the International Linear Collider*, May 2008., JINST 3:P08001,2008., e-Print: arXiv:0805.4833.
- 3) N. D'Ascenzo, E. Garutti, M. Goettlich, H.C. Schultz-Coulon, A. Tadday. *Study of Micro Pixel Photon Counter for the Application to Positron Emission Tomography*, DESY-08-047, May 2008., e-Print: arXiv:0805.0525.
- 4) E. Garutti. *CALICE scintillator HCAL - electromagnetic and hadronic shower analysis*, Proceeding to the CALOR08 conference, 26-30 May 2008, Pavia (Italy).
- 5) E. Garutti, M. Goettlich, H.C. Schultz-Coulon, A. Tadday, et al. *Application of Multi-Pixel Photon Counter to Positron Emission Tomography*, Proceeding to the IEEE08 conference, 19-25 October 2008, Dresden (Germany).
- 6) N. Feege *Silicon Photomultipliers: properties and application in a highly granular calorimeter*, Diploma thesis.

- 7) S. Richter *Validation of the calibration procedure for a highly granular calorimeter with electro-magnetic processes.* , Diploma thesis.
- 8) A. Tadday *Characterisation of Silicon Photomultipliers.* , Diploma thesis.
- 9) N. Meyer *Muon, electrons and hadrons in the CALICE tile hadron calorimeter prototype.* , Poster presented at the ICHEP conference, Philadelphia.
- 10) N. Wattimena *The CALICE tile hadron calorimeter prototype with SiPM readout: design, construction and first test beam results.* , Proceeding to the Astroparticle, Particle and Space Physics, Detectors and Medical Physics Applications conference, Como, Italy.