# T 93: Detektorsysteme VI

Zeit: Donnerstag 16:00–18:30 Raum: H08

T 93.1 Do 16:00 H08

**Erfahrungen aus dem Einsatz von DC-DC-Konvertern im CMS Phase-1 Pixeldetektor** — •Martin Lipinski, Karl-Heinz Dreger, Lutz Feld, Waclaw Karpinski, Katja Klein, Franz Josef Neus, Irfan Ötzen, Alexander Pauls, Gerhard Pierschel, Marius Preuten, Max Rauch, Stefan Schmitz und Michael Wlochal — I. Physikalisches Institut B, RWTH Aachen University

Im Rahmen des Phase-1 Upgrades wurde ein neuer Pixeldetektor in das CMS-Experiment installiert. Für diesen wurde eine neuartige Spannungsversorgung entwickelt, um Verluste auf den Versorgungskabeln deutlich zu verringern. Dabei wird eine Speisespannung von etwa 10 V erst im Detektor mit DC-DC-Konvertern auf die benötigten Spannungen von etwa 3 V transformiert. Dies ist der erste Einsatz von strahlungstoleranten und magnetfeldresistenten DC-DC-Konvertern innerhalb eines Detektors in einem Experiment der Hochenergiephysik.

Nach einigen Betriebsmonaten kam es zu unerwarteten Ausfällen, sodass am Ende des Jahres 2017 etwa 5% der installierten DC-DC-Konverter nicht mehr funktionierten. In diesem Vortrag wird die Problemsuche und die Ursache der Defekte vorgestellt. Alle DC-DC-Konverter wurden vor Beginn der Datennahme im Jahr 2018 ausgetauscht. Seitdem gab es keine neuen Ausfälle.

T 93.2 Do 16:15 H08

**Power distribution for the Mu3e experiment** — •Frederik Wauters for the Mu3e-Collaboration — Johannes Gutenberg Universität, Mainz

The Mu3e experiment aims to measure the charged flavour violating decay $\mu^+ \rightarrow e^-e^+e^+$ with a single events sensitivity of $2{\cdot}10^{-15}$ in the first data taking phase. For this purpose, a DC muon beam of $10^8\mu^+$/s will be stopped inside a Si pixel tracker constructed from High-Voltage Monolithic Active Pixel Sensors (HV-MAPS), complemented with timing detectors. The entire experiments resides within a superconducting solenoid proving a homogeneous magnetic field of 1 T. All 3136 detector ASICs combined need about 5 kW of power at 1.8 V. In addition, the serial data from the indiviual sensors is processed by front-end FPGAs before being send off via optical links to the outside, adding another 2.7 kW of power needed at voltages of 1.1 to 3.3 V. This requires a power distribution system wich works inside the magnetic field and takes into account to the tight space constrains of the experiment. DC-DC buck converters with custom aircoils will drop down the incoming 20 VDC to the lower voltages. LDO regulators will provide the low noise power lines needed by the electronic. Special care has to be taken distibuting the low voltage power to the electronics and sensors.

T 93.3 Do 16:30 H08

**Serial Powering Tests with RD53A** — Matthias Hamer[1], •Florian Hinterkeuser[1], Fabian Hügging[1], Dominik Koukola[2], Hans Krüger[1], Susanne Kuehn[2], Stella Orfanelli[2], and Klaus Desch[1] — [1]University of Bonn — [2]CERN

The high luminosity upgrade for the Large Hadron Collider at CERN requires a complete overhaul of the ATLAS detector. The current tracking detector will be replaced by an all-silicon tracking detector, the ITk. It will occupy the same volume as the current ATLAS tracker and will cover a significantly larger phase space. The new Front-End chips for the pixel detector are developed within the RD53 collaboration together with CMS. Due to the increased power consumption and the increased number of modules, a serial powering scheme has to be deployed. While the concept of serial powering has already been proven using FE-I4 readout chips, detector prototypes with the new FE chips are now being built by the ITk collaboration. This talk will present an overview of first serial powering tests with RD53A, the current prototype readout chip for ATLAS and CMS, focusing on on-module current distribution and HV distribution in a serially powered chain.

T 93.4 Do 16:45 H08

**Beam Test measurements of silicon-strip modules for the ATLAS Inner Tracker upgrade** — Carlos Garcia Argos, Mark Hauser, Ulrich Parzefall, •Arturo Rodriguez Rodriguez, Frederik Ruehr, Dennis Sperlich, and Liv Wiik — Albert-Ludwigs-Universität, Freiburg, Germany

For the high luminosity phase of the LHC, the tracking system of the ATLAS experiment will be replaced with a new all-silicon detector called the Inner Tracker (ITk), to cope with the expected severe conditions in terms of radiation and occupancy. With the production of modules scheduled to begin in 2020, a thorough understanding of the current prototype modules is critical. Beam Tests allow, to some extent, to simulate real experimental conditions and test the module performance. This talk presents the results of beam tests at DESY and CERN. The devices under test are the first ever double-sided R0 module built from non-irradiated silicon sensors and a single R0 module irradiated up to a dose of $1.1 \times 10^{15}$ $n_{eq}/cm^2$. The R0 module will occupy the innermost position in the end-cap wheels of the ITk-strip detector system and will face the highest radiation dose. The results presented focus on the detection efficiency and spatial resolution of the modules.

T 93.5 Do 17:00 H08

**Testbeam results of irradiated and non-irradiated silicon strip sensors with embedded pitch adapters** — Ingo Bloch[2], Javier Fernández-Tejero[1], Celeste Fleta[1], Heiko Lacker[3], •Sam Yanwing Ng[3], Luise Poley[4], Laura Rehnisch[3], Edoardo Rossi[2], Christian Scharf[3], and Miguel Ullán[1] — [1]Centro Nacional de Microelectrónica — [2]Deutsches Elektronen-Synchrotron — [3]Humboldt-Universität zu Berlin — [4]Lawrence Berkeley National Lab

Embedded pitch adapters (EPA) are used to adjust the bond pattern of segmented sensors to that of read-out chips. In this way the sensor geometry can be made independent of the bond pattern of the read-out chips. This can be very useful for challenging sensor geometries used in the trackers of several experiments. However, the EPA may lead to efficiency loss due to coupling to the bulk or the strip metallization.

For the high-luminosity upgrade of the ATLAS inner tracker, silicon strip sensors with EPA structures have been investigated as an approach to mitigate the challenging wire-bonding in the end-cap region. Prototype end-cap silicon strip sensors with various EPA structures have been produced by Centro Nacional de Microelectrónica (IMB-CNM, CSIC), Barcelona, Spain. A non-irradiated sensor and a sensor irradiated to $\Phi_{eq} = 10^{15}\,n_{eq}{\cdot}cm^{-2}$ with MeV protons were subjected to test beam at DESY using a 4.4 GeV electron beam with a EUDET-type pixel telescope. First results of the tracking efficiency in the region of the EPA compared to the standard sensor region as well as a study of the coupling between the EPA and the bulk will be presented.

T 93.6 Do 17:15 H08

**Thermische Messungen mit 2S-Modulen für das Phase-2-Upgrade von CMS** — Christian Dziwok[2], Lutz Feld[1], Waclaw Karpinski[1], Katja Klein[1], Martin Lipinski[1], Irfan Özen[1], Alexander Pauls[1], Oliver Pooth[2], Marius Preuten[1], •Max Rauch[1], Nicolas Röwert[1], Nick Thamm[2], Michael Wlochal[1] und Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

Im CMS Phase-2 Tracker werden u.A. ca. 8000 Stück neuartige 2S-Siliziumstreifenmodule eingesetzt werden. Ein 2S-Modul besteht aus zwei 10 cm × 10 cm-großen Siliziumstreifensensoren und drei Hybriden zur Spannungsversorgung und Auslese. Die elektrische Modulleistung nach HL-LHC-Bestrahlung wird mit etwa 6 W abgeschätzt, wovon etwa 1 W durch Leckstrom in den Sensoren entsteht. Die 2S-Module werden mit einem zweiphasigen $CO_2$-System bei einer nominellen $CO_2$-Temperatur von −35 °C gekühlt. Das thermische Verhalten der 2S-Module wie z.B. der Effekt des „Thermal Runaway“ wird mit FE-Analysen simuliert. In diesem Vortrag werden thermische Messungen mit 2S-Dummy-Modulen vorgestellt. Die in den FE-Analysen gemachten Annahmen wie Klebeschichtdicken, Wärmeleitfähigkeiten etc. werden durch die Messungen überprüft. Ein detailliertes Verständnis und eine gezielte Kontrolle der äußeren Einflüsse erlauben präzise Aussagen über das thermische Verhalten des 2S-Moduls.

T 93.7 Do 17:30 H08

**Thermal performance measurements of petals for the ATLAS ITk strip detector upgrade** — •Jan-Hendrik Arling — Deutsches Elektronen-Synchrotron DESY, ATLAS group, Hamburg — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, Dortmund

The Inner Tracker (ITk) is the new tracking detector for the phase-II

upgrade of the ATLAS experiment, meant to meet the challenges at the high-luminosity LHC. The forward regions (end-caps) will be populated with modules consisting out of silicon micro-strip sensors with readout and power electronics. These modules are directly glued on local support structures (petal core), consisting of carbon fiber-based sandwich structures with embedded titanium cooling pipes as well as data and power buses. This structure has to provide mechanical stability while minimizing material and allows for evaporative CO2 cooling of sensors and electronics. The combination of modules and support structure is a petal.
For the optimization of the petal design, petal core prototypes as well as a thermo-mechanical petal prototype, fully loaded with dummy silicon modules emulating the real heat load, were constructed. A set of measurements has been performed on these objects to validate the petal design. One type of tests is to assess the thermo-mechanical behaviour using dual-phase CO2 cooling by applying infrared thermography on it. In a developed setup experimental results for the prototypes were taken and used to validate FEA simulations.
In this talk, results in terms of thermal performance of the petal as well as properties of the CO2 cooling will be discussed.

T 93.8 Do 17:45 H08

**Qualifizierungsmessungen im Rahmen der ATLAS-ITk-Pixel Market-Survey** — Andreas Gisen, •Valerie Hohm, Kevin Kröninger, Alexander Kroner, Mareike Weers und Jens Weingarten — TU Dortmund, Experimentelle Physik IV

Der aktuelle Inner Detector des ATLAS-Experiments wird beim Upgrade des LHC zum HL-LHC durch den Inner Tracker (ITk) ausgetauscht. Dies ist durch die zukünftig höhere Luminosität bedingt, die größere Strahlenschäden und eine höhere Okkupanz hervorruft. Der ITk-Pixeldetektor wird zum großen Teil aus planaren Silizium-Pixelsensoren bestehen.

Verschiedene Hersteller können sich für die Produktion dieser Sensoren qualifizieren. Die Qualifizierungsmessungen werden mit einem standardisierten Messverfahren an verschiedenen Instituten durchgeführt. Die Dortmunder Arbeitsgruppe beteiligt sich an diesen Messungen für planare Silizium-Pixelsensoren. In diesem Vortrag werden der Messaufbau und die Messmethoden sowie erste Ergebnisse präsentiert.

T 93.9 Do 18:00 H08

**Module building and performance measurements for the ATLAS ITk Pixel Outer Barrel demonstrator** — •Sascha Dungs[1,2], Bora Atlay[3], Helge Beck[4], Jörn Grosse-Knetter[4], Matthias Hamer[5], Fabian Hügging[5], Kevin Kröninger[1], Susanne Kühn[2], Jörn Lange[4], Jannicke Pearkes[6], Heinz Pernegger[2], Alexey Petrukhin[3], Arnulf Quadt[4], Steffen Schaepe[2], and Jens Weingarten[1] — [1]TU Dortmund, Experimental Physics IV — [2]CERN — [3]Uni Siegen — [4]Uni Göttingen — [5]Uni Bonn — [6]SLAC

As part of the Phase-II upgrade of the ATLAS detector, the current tracking detector will be replaced by an all-silicon detector, the Inner Tracker (ITk). The new pixel detector will consist of five central layers and several endcap discs with about 9000 modules. For qualification of system integration aspects, a demonstrator with representative components for the outer barrel layers of the pixel detector is currently being installed.

In this talk, the production of about 70 hybrid pixel modules with two or four readout chips will be presented. This production was done in different steps at various institutes. Particular focus will be placed on flex attachment and wirebond encapsulation. To qualify these production steps, a careful monitoring of the module performance is essential after each stage. An overview will be given about the testing procedure and the result of the performance measurements of these modules.

T 93.10 Do 18:15 H08

**Assembly and test of 2S modules for the Phase-2 CMS Outer Tracker** — Christian Dziwok[1], Lutz Feld[2], Katja Klein[2], Martin Lipinski[2], Alexander Pauls[2], Oliver Pooth[1], Marius Preuten[2], Max Rauch[2], Nicolas Röwert[2], Nick Thamm[1], and •Tim Ziemons[1] — [1]III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]I. Physikalisches Institut B, RWTH Aachen University

The CMS detector will be upgraded in the Phase-2 Upgrade for the HL-LHC. Among others the silicon tracking system will be completely replaced by a new system providing an extended acceptance, an improved granularity and the feature to include tracking information into the level-1 trigger. The new Outer Tracker will consist of 2S modules with two strip sensors and PS modules with a macro-pixel sensor and a strip sensor.

At RWTH Aachen University about one thousand 2S modules will be assembled. In this talk, the assembly of the first functional module prototypes is presented. Additionally, tests to check mechanical properties as well as electrical tests are shown.