18 Electronics Workshop

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In parallel to ongoing maintenance work for existing laboratory equipment and constant support for the experimental setups of the scientists the electronics workshop contributed to various projects of the research groups.

For the group of Prof. Baudis, prototype amplifier modules with dual outputs (gains of 1 and 20) for each channel have been developed (Fig. 18.1) to be used in the XENONnT project (Sec. 4). Several versions have been developed to match the signal input levels of the existing DAQ system while aiming for low input amplifier noise. A compact design allows for integration of 16 low-noise channels into a standard NIM-module by mounting the required voltage regulators on a dedicated backplane which not only acts as a mechanical mount but also as thermal radiator.

We also contributed to the final commissioning of the CMS pixel detector upgrade (Fig. 18.2) for the groups of Profs. Kilminster and Canelli (Sec. 10). Printed circuit boards for the pixel supply tube were designed in our workshop and their production in industry was supervised. The required cabling for those boards was manufactured in house followed by the assembly of the pixel detector in the mechanics workshop. A LabView graphic user interface was developed to visualize the temperatures that are recorded with these circuit boards.

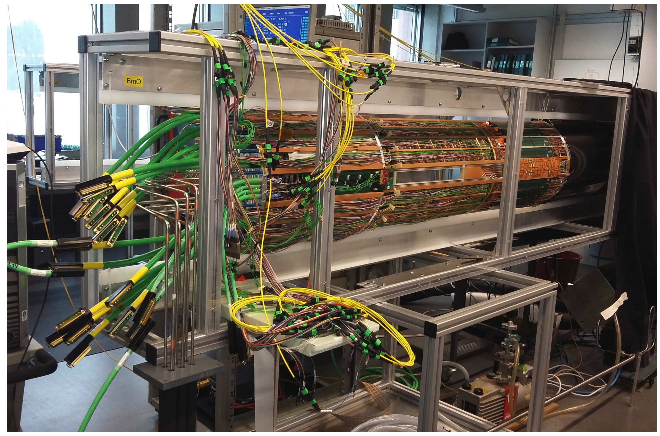

Fig. 18.2 – CMS Pixel detector during final assembly.

When operating experimental setups in remote locations with little human intervention, close monitoring of the current state is crucial. However, for some situations a response within a short time frame is still required. To allow for fast automated reporting, independent of the state of internet access, a Raspberry Pi single board computer was interfaced to a GSM-modem to enable both messaging and voice calls to predefined piquet telefone numbers (Fig. 18.3). Voice messages can be synthesized in real-time or pre-recorded sound files are played once the call receiver has picked up the phone. The device will be used in the CONNIE experiment (Sec. 5).

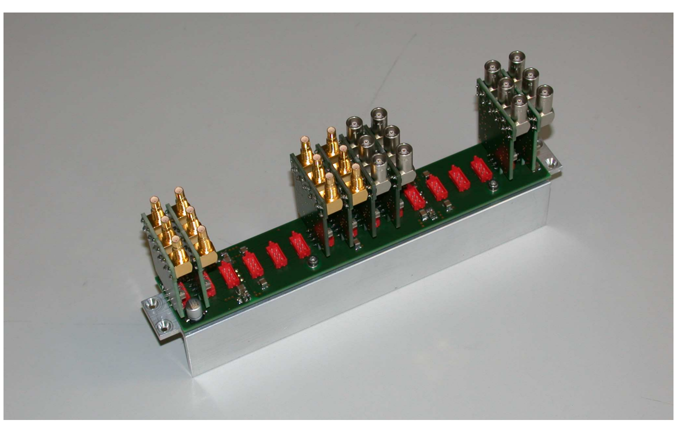

Fig. 18.1 – Prototype of a 16-channel amplifier unit for the Xe-nT detector.

Fig. 18.3 – GSM-alarm unit.

A quad channel bias voltage supply to operate Geiger-mode APDs (Fig. 18.5) has been developed for the group of Prof. Straumann. The channels are individually adjustable between 2 and 80 Volts with a resolution of 1.3 mV while maintaining an excellent temperature stability of less than 5 ppm/K. The power supply unit can be operated locally via the touch screen display or remotely via a USB interface.

Other activities for the CTA project of Prof. Straumann included the development of a new power supply for the photon detector plane of the FlashCam project (Sec. 6). Measurements during integration of the first prototype indicated an excess of noise which was found to originate from the switched mode power supply. A new version with vastly reduced electromagnetic emissions has been successfully tested and is being included in the next version of the photon detector plane electronics. Two power supply cabinets were completed and are undergoing long-term testing. One cabinet will provide the supply for one camera. The integrated FlashCam safety firmware was upgraded and documented for discussion with the CTA consortium. The active mirror control (AMC) actuators are further contributions to the CTA project. They serve to fine adjust the mirror facets of the Large Size Telescopes (LST). Together with collaborators of the Institute for Cosmic Ray Research (ICRR) in Japan it was determined that the actuator sensor package stops working properly below -15° C. Upgrades to the design and changes in the controller firmware mitigated this problem. The modifications will be integrated in a future mass production for the CTA project. Further changes in the actuator electronics will allow for in-field upgrades of the firmware without physically accessing the unit (wireless bootloader) and monitoring of the internal humidity to check for leaking seals.

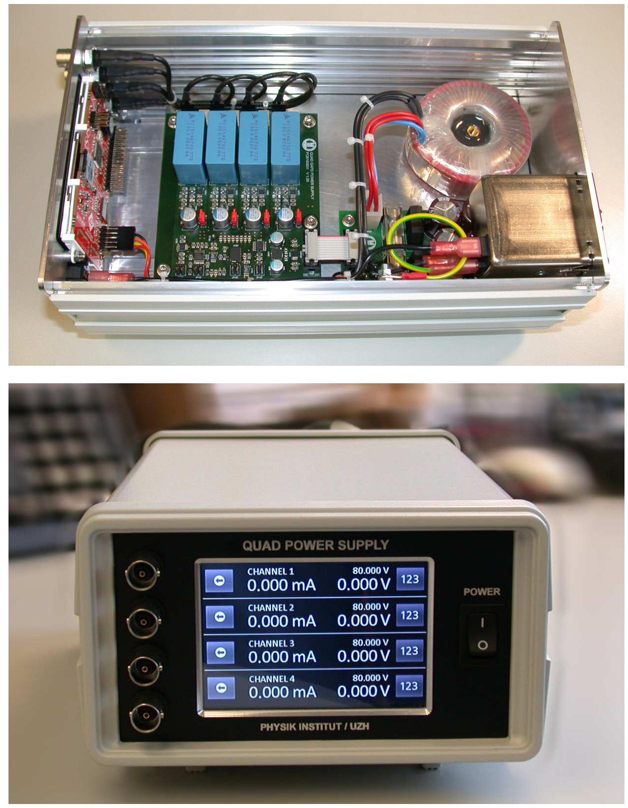

FIG. 18.5 – Internal (top) and front (bottom) view of the Geiger-APD bias power supply.

For the International Physics Olympiad (IPHO) 2016 250 experimental setups were built and tested. The electronics for two experimental problems was included in one electronics box design (Fig 18.6) to keep the manufacturing cost low and allow for a fast commissioning of the box.

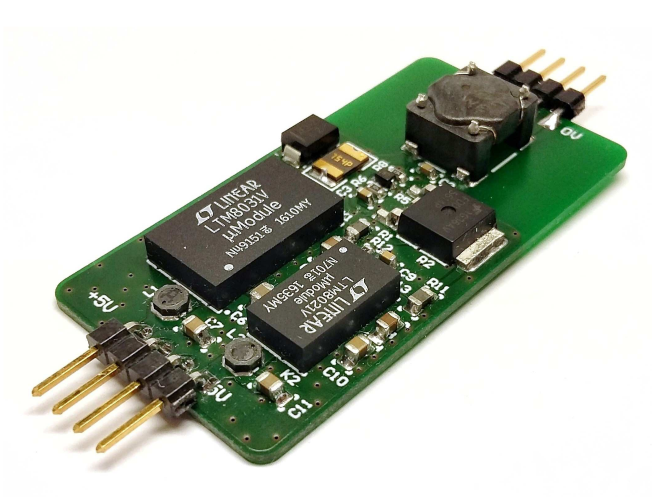

FIG. 18.4 – Switched mode power supply, optimized for low EM-emissions.

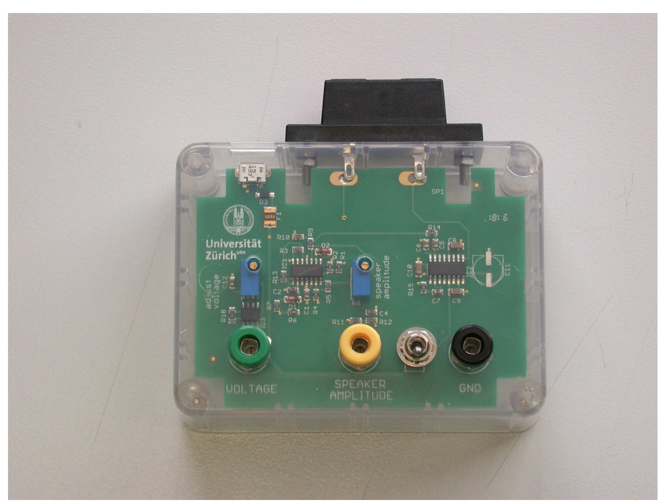

FIG. 18.6 – Electronic box for the two IPHO 2016 experimental problems.

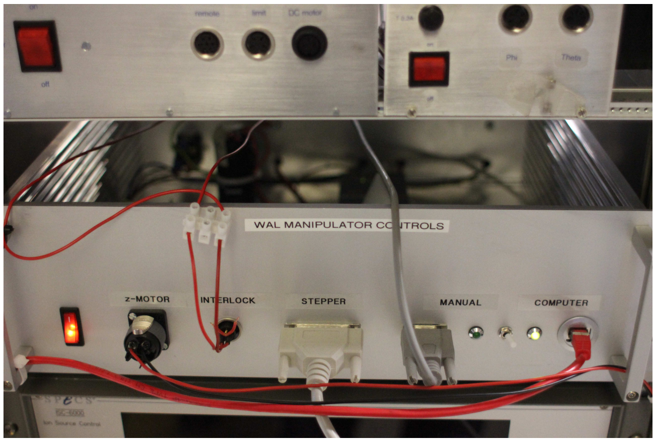

FIG. 18.7 – Ethernet-based controller for a 5-DOF UHV manipulator

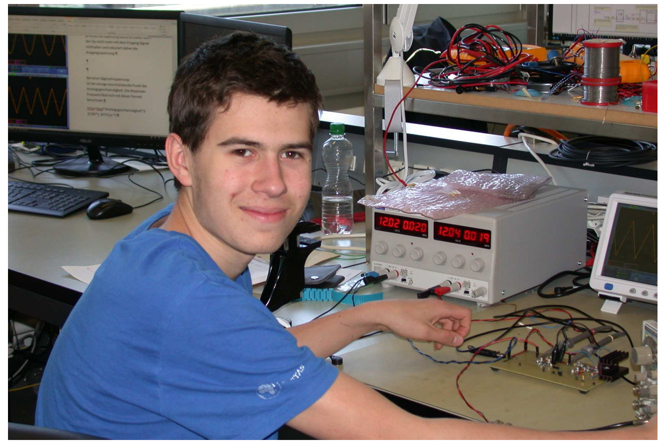

FIG. 18.8 – Simon Karrer - apprentice in the electronics workshop since August 2016.

A 5-DOF manipulator inside an ultra-high vacuum setup was designed and commissioned (Fig. 18.7) for the group of Prof. Osterwalder (Sec. 14). Previously, the five stepper motors were individually connected with separate USB interfaces to a host computer for remote control. The upgrade was performed to significantly simplify the cabling via daisy-chaining the motors over a common control bus which is then connected to the host computer via Ethernet. This setup allows for long-range cabling. Furthermore a manual remote controller was added to the setup to allow for individual local steering of any of the five motors.

Since August 2016, the electronics workshop educates an apprentice (Simon Karrer, Fig. 18.8), who has started his 4-year higher education as electronic technician (Elektroniker EFZ). Three days a week he is being trained in the electronics workshop where he joins ongoing work for the research groups where possible in addition to his general training. The remaining two days per week he follows external courses in general education, languages and science. It is planned to have a second apprentice starting in August 2018.