18 Electronics Workshop

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During the reporting period the electronics workshop again supported the research groups by maintaining and repairing their equipment. For various experiments at the institute electronic circuits were designed and test setups assembled. In collaboration with Hp. Koch and L. Pauli who are responsible for the preparation of the demonstration experiments for the undergraduate lectures we renewed and improved again some devices and setups.

Below we list some major activities:

- **Electronics for the Cherenkov Telescope Array (CTA) experiment (Sec. 6)**
  A decentralized master clock scheme is under study. To maintain a fixed phase relation between independent clock sources, a GPS-disciplined crystal oscillator unit was developed. As high-resolution phase measurements are required for characterizing the relative stability of two clocks, a time-to-digital converter with a noise floor of 60 ps was designed (Fig. 18.1). The phase data is transmitted to a host computer for further analysis. Two prototypes of the GPS-disciplined oscillator have been built and are currently being optimized (Fig. 18.2). Recent tests suggest a relative frequency instability below $2{\cdot}10^{-11}$ for a time period of 100 seconds. This result is probably limited by the quality of the reference oscillator. For a more accurate analysis, a comparison to the METAS atomic time standard is planned.

  In addition, 200 controllers for the Active Mirror Control (AMC) electronics were procured and commissioned. Mounting on the full-size prototype dish structure is planned for summer 2011. To assist these tests, a small AMC Master Controller (Fig. 18.3) connecting to a host's USB interface was designed. Depending on the chosen

Fig. 18.1 – Time-to-digital converter.

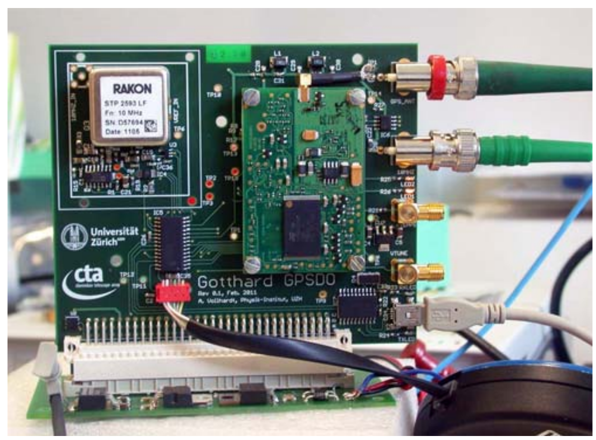

Fig. 18.2 – GPS-disciplined oscillator.

Fig. 18.3 – AMC master controller unit.

concept the bandwidth required to transfer the CTA FlashCam trigger data reaches up to 480 Gb/s. For test purposes we designed and built an interface board (Fig. 18.4).

Using a Xilinx evaluation-board and with the appropriately programmed FPGA we performed measurements with transfer rates up to 2.5 Gb/s. We also tested different types of interfaces (Low Voltage Differential Signaling (LVDS), Current Mode Logic (CML)). Among other topics we also studied the alternative to use standard and cheap RJ-45 network cables for the data transmission.

- **X-ray tube control unit (Sec. 13)**
  For the recently acquired X-ray tube, a custom made control panel was constructed (Fig. 18.5) which allows control and monitoring of anode voltage and current. In case of an open radiation shield or missing water cooling, an interlock circuit automatically shuts down the tube's anode voltage providing safe conditions for both the operator and the hardware.

- **Solid State Physics (Sec. 12)**
  We designed and built a manually controlled constant current source to power a spectrometer magnet. A microwave spectrometer used in the ESR-laboratory and other spectrometers had to be repaired. Because a part of the faulty components had to be replaced by alternative devices we had to redesign and rebuild a complete device.

- **Surface Physics (Sec. 14)**
  For the sensitive light readout of a Mott spectrometer we designed a galvanically isolated interface with different amplifiers for avalanche photo diodes (APD). A final assembly was then realized on a printed circuit board (Fig. 18.6).

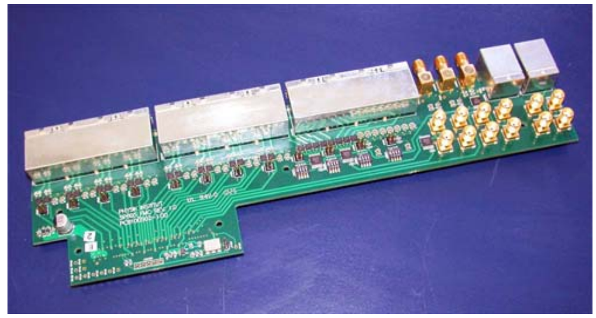

Fig. 18.4 – Interface board.

Fig. 18.5 – X-ray tube control unit.

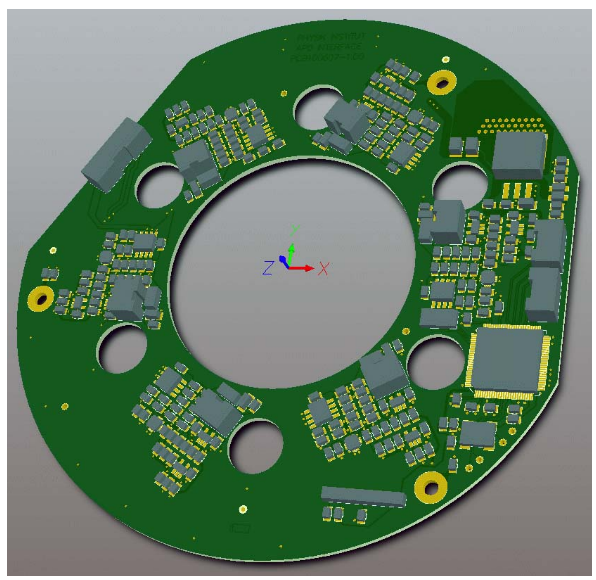

Fig. 18.6 – Printed circuit board design of the APD-interface.

The output signals of 6 APD-amplifiers are digitised with fast anolog comparators with adjustable thresholds. With a Complex Programmable Logic Device (CPLD) on the printed circuit board the width of the output pulses can be adjusted to a preselected value. We also assisted an engineer student in designing and assembling a custom-built heater control unit.

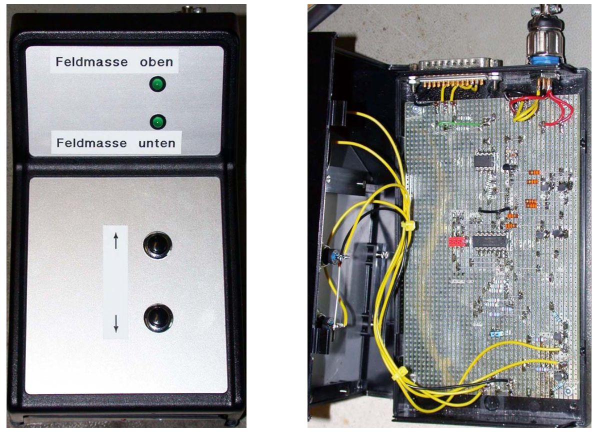

Fig. 18.7 – Left: control panel of the interface. Right: interface electronics.

- **Demonstration and laboratory experiments**
  A new control interface for the student experiment determining the gravitational constant was built (Fig. 18.7). The interface allows both manual control and computer control of the position of the fieldmass while limiting the drive range via end switches.

- **LHCb experiment**
  During the LHC winter break 2010/11, malfunctioning readout boards of the LHCb Silicon Tracker were replaced. In addition the electronics workshop provided assistance during testing and installation of replacement silicon detector modules.