13 Electronics Workshop

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The electronics workshop supports all research groups in maintaining and repairing the existing devices. We also help to evaluate and procure new equipment. In collaboration with L. Pauli and J. Seiler, who are responsible for the preparation of the experiments, we constantly improve and renew the demonstration experiments in the lecturer hall. In connection with the electronics laboratory courses for the bachelor students we procured a set of micro-controllers and prepared some tutorial lab sessions. Different seminars, courses and exhibitions were attended to remain up-to-date in this fast-developing field. Besides many small modifications of modules, repair work and design and construction of simple circuits and prototypes for the laboratories, the main effort went into the following projects:

- For the LHCb inner tracking detector (Group Straumann, see Section 6) we assembled the complete set of detector high voltage and slow control cables. Here we also redesigned the special jumper cables, which connect the detectors through the walls of the detector housings to the readout electronics, for the final series production. These cables with a very small pitch and tiny tracks consist of flexible printed circuit boards.

- For the CMS Barrel Pixel detector (Group Amsler, see Section 7) a series of printed circuit boards for the detector readout and control electronics were designed. A complete prototype system was assembled and tested. We also designed the Barrel Pixel detector front-end control system with the associated communication and control unit boards (CCU boards). A section of such board installed in the test setup is shown in Fig. 13.1.

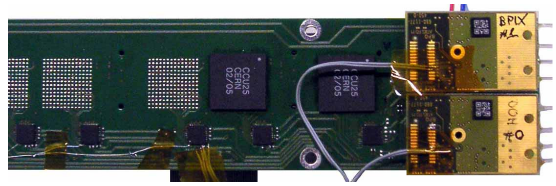

Figure 13.1:
Section of the CCU board with the two installed digital opto-hybrids. Note that the test setup board is equipped with only two CCU chips.

The corresponding electronics connect the detector system to the front end controller module (FEC), which is the master of the network and uses two optical fibres to send the timing and data signals to a number of slave CCU nodes, and another two fibres to receive return communication traffic. The two receiver channels on the digital opto-hybrid (DOH) transmit the 40 MHz clock and control data at 40 Mbit/s from the FEC to the ring of communication and control units (CCUs). The two transmitter channels send clock and data back to the FEC from the ring of CCUs. The CCU chip is the core component developed for the slow control, monitoring and clock distribution in the CMS tracking system. Each chip contains various types of peripheral controllers and has dual network input and output ports allowing the cabling of a redundant network. Inside the chip, critical circuitry is tripled and a majority-voting scheme is used to cope with errors caused by single event radiation effects. The design was fabricated with a library in rad-tolerant 0.25 μm CMOS developed at CERN. Each board carries nine of these chips packed in a 196 pin ball grid array. The whole system had to undergo also a high voltage test because it provides in addition the detector bias voltage of 600 V at maximum.

- For the SCOPES project we built a second unit of a 70 MHz NMR spectrometer consisting of the high frequency part and the corresponding power supply. Figure 13.2 shows an insight of the high frequency part.
- In collaboration with the Glaciology and Geomorphodynamics Group from the Department of Geography of the University we designed the printed circuit board for a dedicated sensor. The sensors are used to measure the heat flux and phase change processes in porous fractured rock. These measurements are needed in order to develop theoretical models for hazard assessment and the support of infrastructure maintenance. The sensors are mounted in a fiberglass rod and measure temperature and electrical conductivity between electrodes with high accuracy at four depths inside the 95 cm deep drill hole. The direct current conductivity of the rock depends on its pore water content and the phase state of this water. The resistance of dry rock is orders of magnitudes higher compared to saturated but frozen rock and if this water thaws the resistance decreases again by about two orders of magnitudes. Measurement electronics are kept inside the rod to minimize the effect of temperature fluctuations. As drilling effort should be minimized, the diameter of the drilling hole is only 14 mm. Hence the wiring and mounting of the electronics became a challenge. We designed the special printed circuit board for the sensor with a width of only 9.7 mm and a length of 185.2 mm (see Fig. 13.3). We also helped the colleagues in putting the electronics into operation and in improving the electronics circuits.

Figure 13.2: The SCOPES 70 MHz NMR-spectrometer high frequency device.

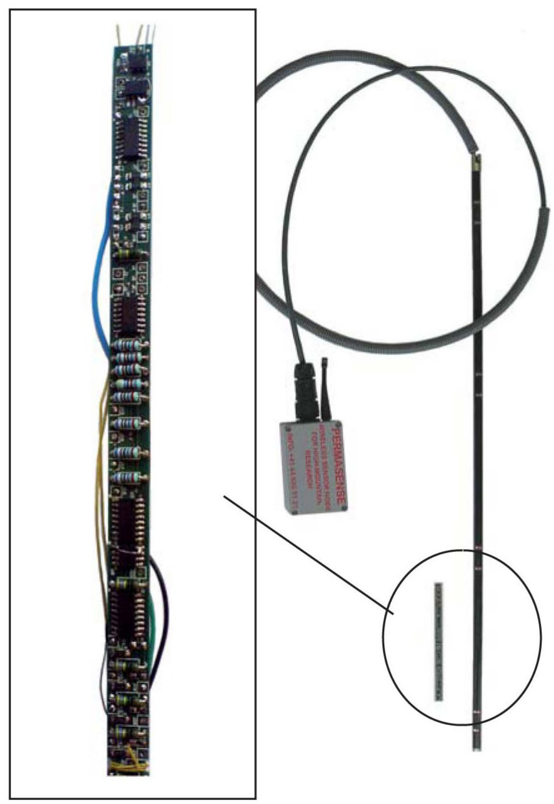

Figure 13.3: Complete PERMASENS sensor with the enlarged printed circuit board.