Test of prototype modules of the CBM Silicon Tracking System in a proton beam at COSY

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In December 2010, prototypes of CBM's silicon tracking detector system, the muon detection system, and readout electronics were tested in a 3 GeV/c proton beam at COSY, Forschungszentrum Jülich, Germany [1]. The experimental area "Jessica" was equipped with newly prepared infrastructure from GSI, shown in Fig. 1, foreseeing forthcoming CBM in-beam tests there on a regular basis.

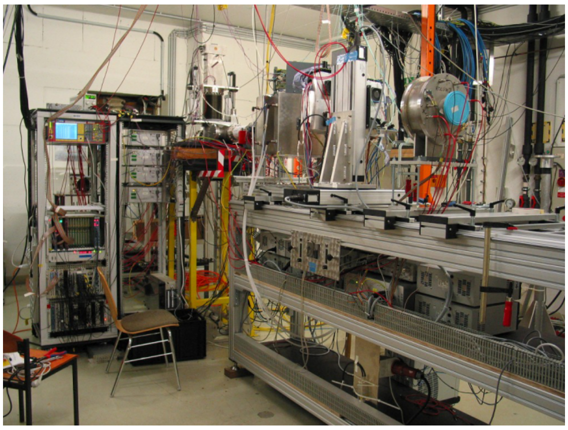

Figure 1: Test beam stand in the Jessica cave at COSY

The prototype Silicon Tracking System comprised two stations based on double-sided silicon microstrip detectors, ultra-thin readout cables, and self-triggering readout electronics (Fig. 2-left). The detectors SPID-CBM02 originate from a cooperation with CiS, Erfurt, and have 256 orthogonal strips per side with 50 μm strip pitch. The detectors were assembled into boards at SE SRTIIE, Kharkov, Ukraine. The readout boards developed at GSI are based on the self-triggering n-XYTER chip. Numerous improvements as compared to the in-beam test of 2009 [2] were introduced on hardware and software levels.

By implementing proper shielding and grounding techniques, the electronic noise was reduced to about 600 e^-, which is now dominated by the preamplifier noise. The n-XYTER temperature was stabilized with water cooling, which abated the problem of the baseline drift significantly. In addition, an automatic baseline calibration was implemented in the data acquisition software and run between the beam spills. A detector control application based on the EPCIS [3] framework was developed and ran on a dedicated PC. All the auxiliary hardware, including power supplies, stepping motors for the GEM and the beam monitoring detectors, water cooling units and temperature sensors were operated and monitored remotely. Some of the measured process variables (STS bias voltages, GEM detector position, temperatures) were periodically inserted into the data stream to study the detector response as a function of those values and to allow for temperature and high-voltage corrections in the on-line and off-line data analyses.

The amplitude response of the silicon detector system was measured as a function of the bias voltage and of the beam incidence angle. Landau-like spectra were clearly seen on the p-side at all bias voltages (50 V – 90 V) and on the n-side starting from 60 V. A cluster analysis of the charge collected in adjacent strips shows peaks at around 140 ADC units corresponding to the most probable signal from the minimum ionizing particles (Fig. 2-right). The signal-to-noise ratio was about 20 in this point. According to a previous calibration of the n-XYTER gain [4], it seems that only 60% of the expected charge was collected on either side of the detector. The reason for the apparently low collection efficiency is to be investigated.

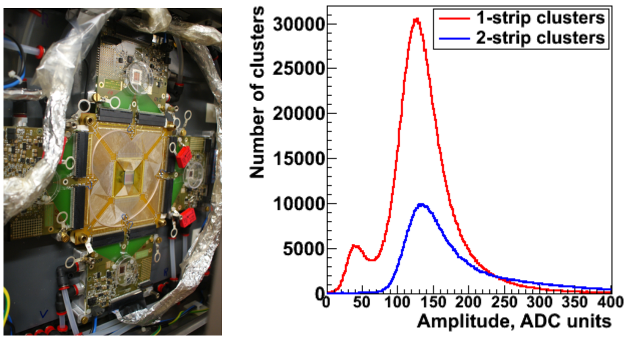

Figure 2: (Left) Opened STS station with the silicon detector board surrounded by readout electronics. (Right) Typical amplitude response spectra, here from the detector n-side, at 70 V bias and normal beam incidence.

References

[1] http://www.fz-juelich.de/ikp/cosy/en/

[2] V. Friese *et al.*, CBM Progress Report 2009, Darmstadt 2010, p. 9

[3] http://www.aps.anl.gov/epics

[4] C. J. Schmidt *et al.*, CBM Progress Report 2009, Darmstadt 2010, p. 50