The Data Acquisition System of the COMPASS Experiment

L. Schmitt, H. Angerer, N. Franz, I. Konorov, W. Liebl, and S. Paul

COMPASS is a new fixed target experiment presently under construction at the CERN Super Proton Synchrotron (SPS) aimed at the study of structure and spectroscopy of hadrons with multiple types of high intensity beams [1].

A polarized muon beam is used for deep inelastic scattering off polarized proton and deuteron targets to study the spin structure of nucleons. In particular open charm production is used to measure the gluon contribution to the nucleon spin. Other items are the study of Λ^0 polarisation and longitudinal and transverse quark polarisation. The physics program connected to hadron beams includes Primakoff scattering of pions and kaons to study their polarisabilities, central production of hybrids and glueballs in a proton beam on a liquid hydrogen target as well as production and leptonic and semi-leptonic decays of charmed hadrons.

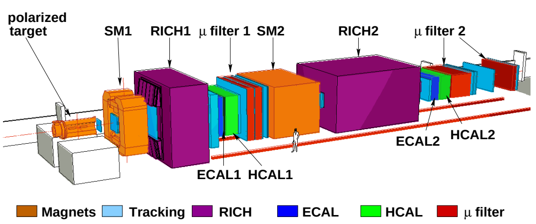

Fig. 1: The COMPASS spectrometer

The COMPASS apparatus is a two stage magnetic spectrometer to obtain a good momentum resolution from $1-2$ GeV up to 150 GeV. Both stages will be equipped with RICH detectors for identification of charged particles, electromagnetic and hadronic calorimeters and muon filters. Tracking detectors will be multi-staged using silicon microstrips in the beam area and gaseous strip detectors (GEM, Micromegas) [2] with larger acceptance immediately around. Behind the first magnet straw tubes provide large area tracking in lower intensity regions. Further downstream standard MWPC can be employed. Scintillating fibre detectors are used as fast beam detectors for timing and triggering.

The experiment will use muon beams of 100 and 200 GeV at a rate of 10^8 particles per second for the deep inelastic scattering program studying the nucleon spin structure. For Primakoff scattering 280 GeV pion and kaon beams are used at 5×10^6 particles per second, for central production 5×10^7 protons per second and for the charm program 5×10^7 pions per second.

The apparatus of COMPASS will have 250,000 channels which are read out by a fast DAQ with minimum deadtime. At a trigger rate of $10 - 100$ kHz and an event size around 30 kB a data rate of 600 MB – 6 GB per SPS spill is reached leading to 300 TB of data per year on tape.

The technique by which these rates can be digested is largely based on pipelined and highly parallelized detector readout electronics. Our group is developing a readout system of this type for silicon and GEM detectors. After the data are read from the detectors they are transferred to memory modules which serve as buffers to reduce the effective transfer rate by making use of the spill cycle of the SPS. The hardware for this buffering following the standards PCI and S-link [3] is developed in our group.

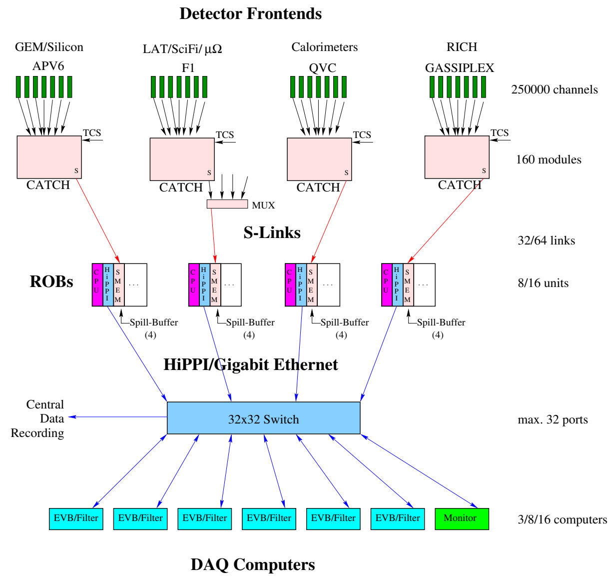

Fig. 2: The COMPASS DAQ system

The subsequent hardware of the DAQ system consists of standard components: Standard high performance PCs host the memory modules and will be connected by a Gigabit Ethernet or HiPPI network [4] to eventbuilder computers, where the data blocks of different detectors are assembled to complete events.

To insure data integrity in the pipelined architecture each trigger has to be labeled by a unique event number. The synchronous transmission of the trigger and its identification is transmitted to all detectors by means of optical links encoded by the Trigger Control System (TCS).

COMPASS will test a subset of detectors in summer 1999 in place at the proper beamline at the CERN SPS. First prototypes of the readout electronics along with memory modules, TCS prototypes and a small scale version of the network DAQ system will be employed during these tests. The design of all components should be finalized during 1999 and production will start by the end of the year.

References

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