Large area GEM tracking chambers for the 12 GeV physics program at the Jefferson Lab Hall A

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We developed and tested [1,2] a new charged particle tracking system, able to operate in high luminosity experiments, which will be installed at Jefferson Laboratory [3] HallA (VA,USA) to optimally exploit the new 12 GeV energy electron beam available at the end of 2013.

The tracker is made of six GEM (Gas Electron Multiplier) large chambers and two 10×20 cm^2 planes of SIlicon microstrip Detectors (SIDs).

The GEM tracker will be placed in the Super Big Bite Spectrometer (SBS), after a momentum analyzing dipole, while the silicon tracker will be sitting very close to the scattering chamber, in order to increase the tracked flying path and the lever arm for better tracking resolution.

Each GEM chamber is composed (Fig. 2) by three 40×50 cm^2 GEM individual modules, having three GEM foils an equipped with two-dimensional strip readout, with expected spatial resolution of about 70 μm.

The same dedicated acquisition system will be used for both detectors (GEM and SID) for a grand total of more than 50,000 channels.

The readout electronics (Fig. 3) is divided into two parts: the front-end cards (based on the existing APV25 chip), hosted on the detectors periphery and the MPD digitizer, a multipurpose

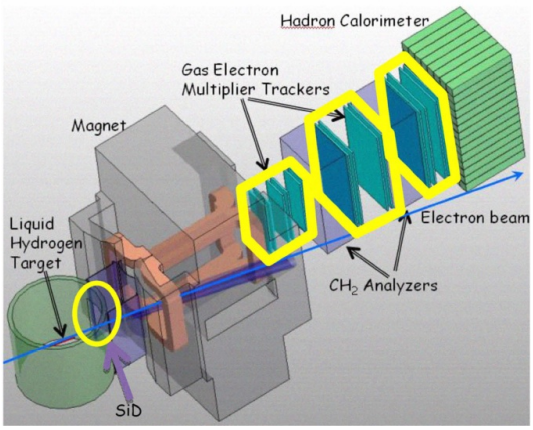

Figure 1. Layout of the SBS spectrometer in Jefferson Lab Hall A.

VME-64x/VXS board located far from the high radiation environment.

This electronics has also been adopted and used by the Olympus experiment [4] (DESY, Hamburg) to readout the six GEM chambers of its luminosity monitor. The experiment data taking came successfully to completion at the end of 2012, having far exceeded the minimal integrated luminosity for the measurement of the two-

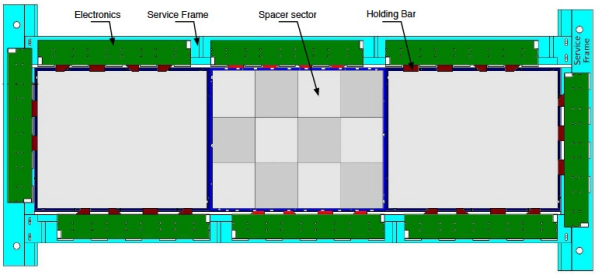

Figure 2. Layout of a GEM tracker chamber for the SBS spectrometer.

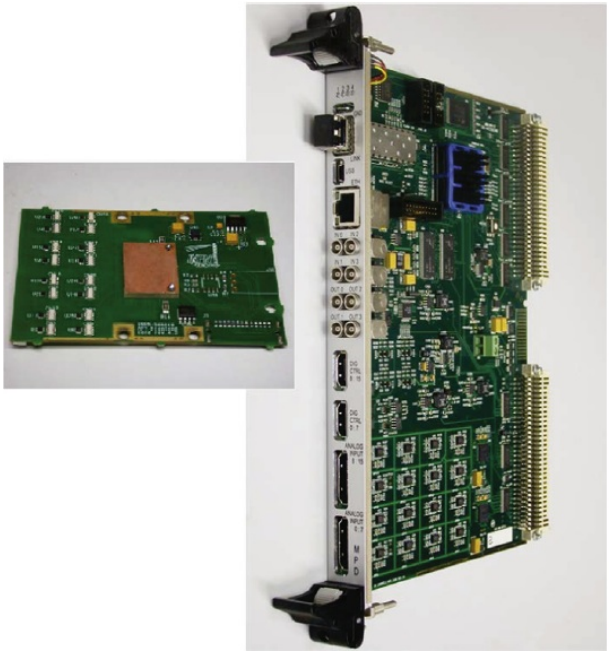

Figure 3. Front-end electronics and DAQ module developed for the present project.

photon contribution to electron/positron scattering off protons.

The developed detectors and electronics are now ready for the production, which will last for the next 2 years.

Mechanics and gas flow for the GEM chambers have been studied by means of finite element analysis (Fig. 4) and a main supporting frame made by carbon fiber was chosen in order to optimize the mechanical stiffness and thermal stability together with the minimization of material budget.

Full scale test triple GEM modules, fully equipped with up to date front-end and DAQ electronics have been regularly tested both with low current electrons at DESY and at Mainz with high current electrons (1 MHz/cm^2, about ten

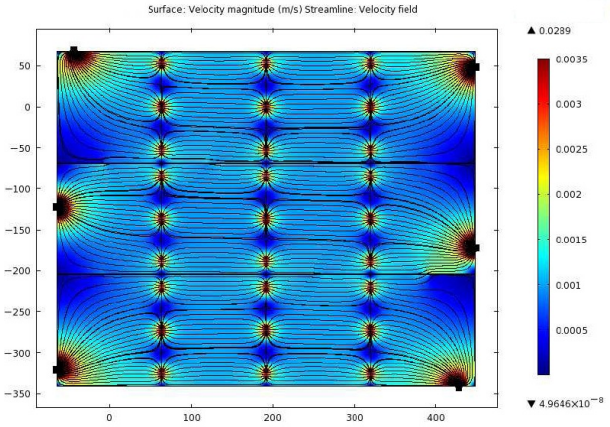

Figure 4. Finite element analysis of gas flow.

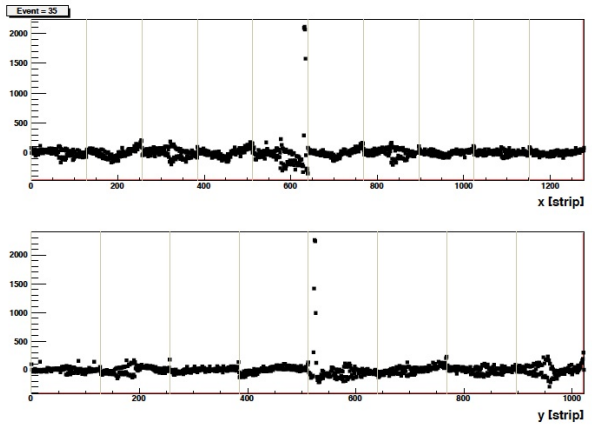

Figure 5. X-Y view of a sample triggered event from DESY test-beam.

times the rate expected in the JLab experiments). Test results (Fig.5) have confirmed the appropriate choices of technology for both the detector and the electronics, which fully meet the expectations for all Hall A planned experiments.

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REFERENCES

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