The high-resolution particle tracking triple-GEM detector for the Test Beam facility at VEPP-4M collider. V.S. Bobrovnikov, V.N. Kudryavtsev, T.V. Maltsev, L.I. Shekhtman. Budker Institute of Nuclear Physics, Novosibirsk State University, Novosibirsk, Russia

Abstract. The goal of the Test Beam facility at the VEPP-4M e+e− collider is to test prototypes of new detectors for particle physics. Measurements taken at this installation require high-resolution low-mass tracking detectors to precisely determine particle trajectories.

The Test Beam facility was built in the Budker Institute of Nuclear Physics at the VEPP-4M e+e− collider for generation of test beams of electrons and photons in a wide range of energies [1]. The installation is designed to test prototypes of detectors for particle physics and has been used successfully for such studies since 2011. As seen in the overview of the facility presented in Fig. 1, four triple-GEM detectors will be installed for the upgrade. The basic principle of the facility operation is the following: when a special probe is being moved close to the beam, generated Bremsstrahlung gamma rays pass through a special channel to the experimental hall and hit the iron(4). The gamma beams are detected through the first pair of coordinate detectors(3), bending magnet(5) and the second pair of the detectors(0), arriving finally at the calorimeter(1). The intensity of the generated electron beam is no less than 50 Hz, while the energy range of gamma rays from 0.1 GeV to 3.5 GeV, the energy resolution of the calorimeter is about 0.5% for energies larger than 0.5 GeV. The energy range is from 0.05 GeV to 4.0 GeV with an accuracy of 0.5% of energy and the designed intensity of the gamma beam is about 1000 Hz [2].

The detector design was finalized according to the results of simulation studies of the limits of spatial resolution of the GEM detector elements and experience gained during the development of the detectors for the DEUTERON PTS system [3, 4]. The prototype detector with high spatial resolution and low material content was developed and, during 2016, the first detector was manufactured (GEMs, flexible readout structures and electronics PCBs made at the CERN Workshop, assembly finalized at the BINP) [5].

The GEM Detector

The detector consists of a triple-GEM, orthogonal X-Y readout structure and detector electronics. Electronics is based on the APC128 ASIC (analog pipeline chip, 128 channels) [6], six of these chips are used covering 768 channels in total. These channels are connected to the readout structure, which has two layers: 512 vertical strips (red colored) and 256 horizontal strips (blue colored), both directions have a 0.25 mm pitch. Thus, the detector sensitive area is 128x64 mm².

In order to minimize multiple scattering the detector elements have a reduced thickness of copper down to 1-2 μm at each GEM side. Such an approach was investigated and it was found that thinning of copper layers does not affect the detector performance.

A triple-GEM detector with thinner copper layers can have the total amount of material seen by particles of ~0.15% of radiation length. The expected spatial resolution of this kind of detector is around 30 μm.

The goal of the Test Beam facility at the VEPP-4M e+e− collider is to test prototypes of new detectors for particle physics. Measurements taken at this installation require high-resolution low-mass tracking detectors to precisely determine particle trajectories.