High-resolution tracking based on scCVD diamond detector for straw tube detector tests *

J. Pietraszko[†1], *W. Koenig*[1], *and M. Träger*[1] *for the HADES and CBM Collaborations*
[1]GSI, Darmstadt, Germany

The scCVD diamond material has been extensively employed for single charged particle detection in high-energy experiments. A fast and radiation hard detector such as this is required and is perfectly suited to record the arrival time of the beam particles, especially in high current experiments, to deliver the reaction time T0 of the heavy-ion (HI) collisions. It has also been demonstrated that the scCVD diamond detector can detect not only HI but also minimum ionizing particles (MIPs) [1] with time resolution, σ, better than 100 ps. The excellent timing properties and charge collection efficiency make this type of detector very attractive for high precision detector tests. In this project, we have demonstrated the excellent position resolution capability of the scCVD diamond detector. This detector was used as a reference detector for straw tube performance studies described in [2]. A high purity scCVD detector with an active area of 4.3 mm x 4.3 mm and a thickness of 300μm was metallized with a 50 nm Cr layer, covered by a 150 nm gold layer and annealed at 500^{o}C prior to the experiment. The detector was mounted to a PCB with 2 stages of amplification, as shown in the Fig.1.

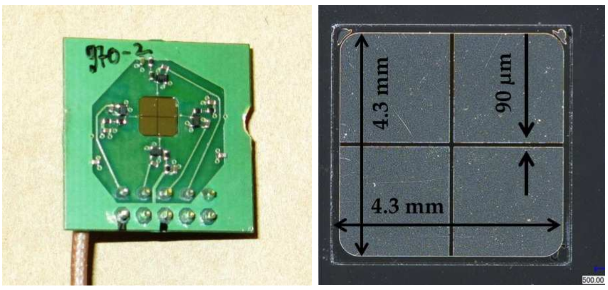

Figure 1: (left) ScCVD diamond mounted on the test PCB, (right) readout electrodes on the scCVD diamond detector.

The concept of high precision position determination is based on charge sharing between two channels when a particle crosses the 90μm gap between the detector electrodes. As shown in Fig.2, the signal height measured by means of this detector is very stable and is equal to about 15 mV. This is an analog signal from 2.95 GeV protons (MIPs) after two stages of amplification. The signal quality reflects the excellent charge collection efficiency of the high purity scCVD diamond material. Owing to this property, the charge sharing method can be used to determine the position of the particle in the 90μm gap by performing a simultaneous measurement of the signal amplitudes.

The concept was tested with a straw tube detector [2].

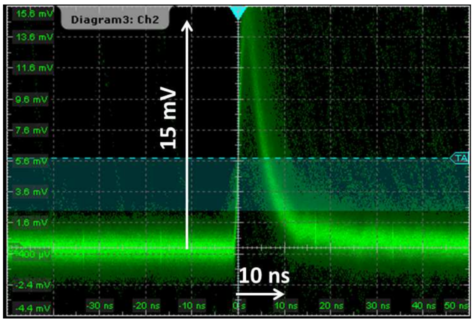

Figure 2: Superposition of about 100 waveforms recorded from the scCVD diamond with a 2.95 GeV proton beam at Cosy Jülich.

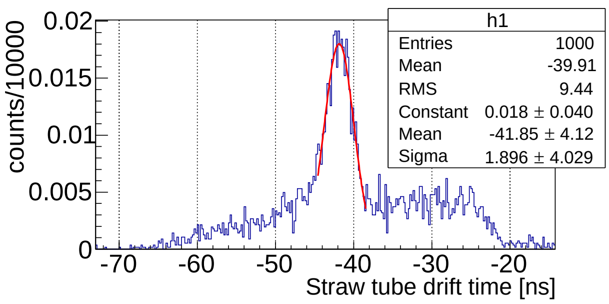

Figure 3: Drift time spectrum from the straw tube measured for one tracker position.

Using diamond position information and precise time measurement the straw tube position resolution has been determined to be about 160μm. This value includes the contribution of the diamond detector. Knowing that this value is very close to the values measured in different experiments we deduced preliminarily that the diamond position resolution has to be better than 50μm. There is also on-going data analysis based on a self-tracking method to determine the position resolution without using the diamond detector. This will allow to determine precisely the position resolution of the diamond tracking detector.

References

[1] J. Pietraszko et al., Diamonds as timing detectors for minimum-ionizing particles, NIM A 618 (2010) 121–123

[2] M. Träger et al., Performance of the straw tube readout based on PADI chip, GSI annual report, 2014.

* Work supported by HIC for FAIR
† j.pietraszko@gsi.de

DOI:10.15120/GR-2015-1-MU-NQM-HADES-28