3 - 18 Design of a Position-Sensitive Time-of-flight Detector for the $B\rho$-defined Isochronous Mass Spectrometry at CSRe and SRing*

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It is well known that the motion of a charged particle with a nonzero emittance in a storage ring is characterized by betatron oscillations in the transverse plane of the ion motion[1]. The effects of the betatron oscillation on the revolution time has been observed in the isochronous mass measurement experiments in CSRe[2]. However, one can not distinguish the pure betareon osilation effects from the effects of intrinsic non-isochronism of the time-of-flight (TOF) detector because the current TOF detector has no position detection capability[3]. The additional position information is very useful for the next generation $B\rho$-defined Isochronous Mass Spectrometers[4] where transverse oscillation motion of ions due to nonzero emittance can be studied more precisely.

In this context, a novel high precision position-sensitive TOF detector has been designed for the future isochronous mass measurement experiments at Cooler Storage Ring (CSRe) and Spectrometer Ring (SRing). Compared with the existing time-of-flight detector, another MCP perpendicular to the carbon foil was added in the new design as shown on the left-hand side of Fig. 1. When an ion passing through the carbon foil, it can induce signals in both the frontal and back MCPs. The time difference of these two signals is dependent on the horizontal position where the ion passing through the carbon foil. Thus the position can be obtained from the time difference. The passing time of the ion can be obtained from the back MCP, similar as the existing TOF detector. Using the SIMION software[5], we simulated the motion of the secondary electrons (SEs) from the two sides of the carbon foil to the frontal and back MCPs, respectively. The time of flight from the carbon foil to the MCP is shown as a function of the horizontal position for every simulated ion in the right of Fig. 1. The design of the detector was optimized, and a time resolution of 16 ps and a position resolution of 0.68 mm were achieved in the simulation. This detector is under construction and will be tested in the laboratory.

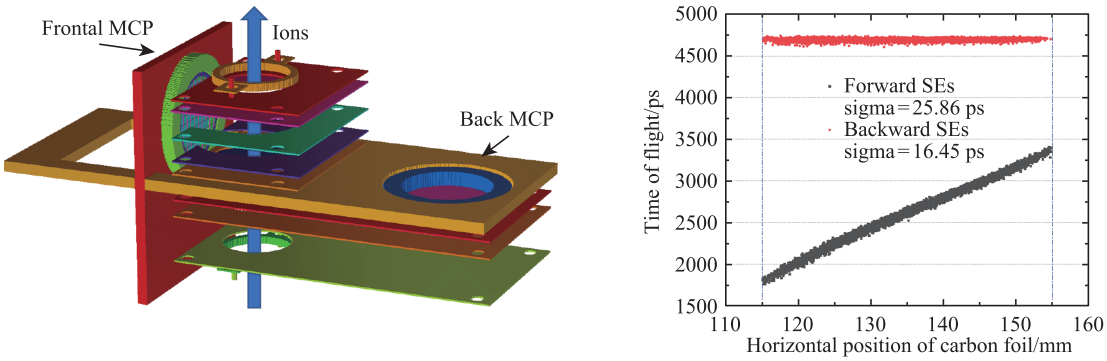

Fig. 1 (color online) Left: The 3D structure of the position-sensitive TOF detector. Right: The time of flight of the SEs on the front(black) and back(red) of the carbon foil at different transverse positions.

References

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