Experimental Investigations and Technical Design for The Time-OF-Flight Detectors in the CR at FAIR.*

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Technical design and performance simulations of a larger TOF detector

To perform isochronous mass spectrometry (IMS) [1] in the future CR at FAIR, investigations in instrumentation and designs for a about a factor 2 larger Time-Of-Flight (TOF) detector have been conducted. For future applications of IMS simulations of the CR have been performed and showed, that the currently used 40 mm diameter carbon foil (areal density: $10\mu g/cm^2$) would be too small for the large emittance of the beam in the CR and too many ions would be lost in each turn. This challenge has been met by the the design of an improved and larger TOF detector. The carbon foil size will be increased from 40 mm to 80 mm diameter and will be used for the first time. Simply increasing the size of the detector leads to decreased timing performance of the detector. To compensate for this one can apply higher voltages to the detector to transport the secondary electrons faster from a carbon foil to the MCPs [2]. As part of the improved design of the larger TOF detector the transport efficency is improved to almost 100% and the timing resolution to 40 ps. All this is achieved while keeping the stringent spatial requirments at the CR.

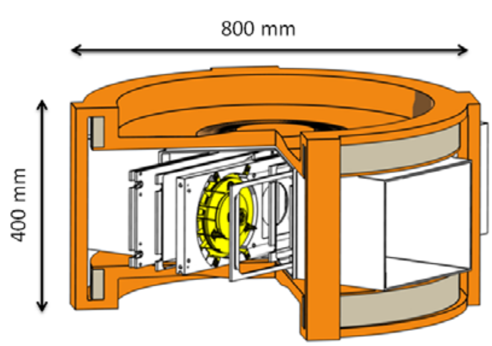

Figure 1: CAD drawing of the new TOF detector surrounded by a Helmholtz magnet for the CR which provides the detector with a homogenious (10^{-3}) magnetic field in the transport area.

Testing of Larger Carbon Foil Properties for a TOF Detector in the CR

In order to investigate the feasibility and the properties of those large carbon foils a test chamber has been built. In this test chamber the possible changes of the physical properties of larger foils compared to the currently used small foils (e.g. flatness of the surface after evacuation of the detector volume) in the timing performance are measured. The test chamber has been operated in a first step with the currently used 40 mm diameter carbon foils. This allows us to see the differences between small and large foils directly. Measurements are performed with an alpha-source from which alpha-particles penetrate the carbon foil in the center of the chamber and emits secondary electrons which are detected by two MCP detectors. Simulations predicted that the secondary electron transport in the setup only contributes with only 2 ps to the timing of the whole measurement. Experimental predictions state, that the measured time uncertainty will therefore be approximately 25 ps and is solely due to effects in the MCPs and flatness of the foil [3].

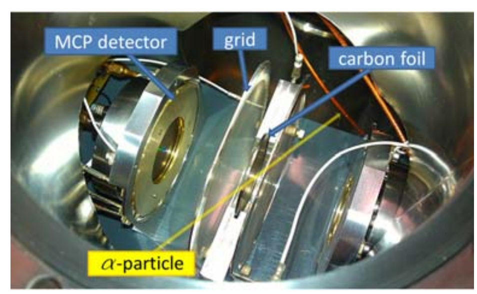

Figure 2: Photography of the assembled test chamber. The carbon foil is placed in the center inbetween two grids. By applying voltages to the grids the secondary electrons are guided to two MCPs on the side. The diameter of the grids is 80 mm and therefore has the same size as the future carbon foils.

As soon as the large foils will be available they will be tested and compared to the small foils.

References

[1] J. Trötscher et al., NIM B 70 (1992) 455-458

[2] M. Diwisch, Master Thesis, JLU Giessen, (2011)

[3] M. Diwisch, PhD Thesis in progress, JLU Giessen, (2014)

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