# Design of the Dual TOF Detector System for Isochronous Mass Spectrometry in the CR at FAIR*

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Isochronous Mass Spectrometry (IMS) was successfully performed for mass measurements of short-lived exotic nuclei at the FRS-ESR facility [1]. With the Super-FRS at FAIR a whole new range of exotic nuclei far away from stability will be accessible [2]. For direct mass measurements of these very short-lived nuclei using IMS, a new dual Time-of-Flight (TOF) detector system will be installed in the Collector Ring (CR).

## Phase Space and Isochronicity in the CR

In order to exploit the full potential of IMS it is important to use the whole phase space volume of the beam provided by the Super-FRS with the detector system at the CR with improved time resolution. The maximum acceptance of the CR in isochronous mode is about 100 mm mrad [3]. The surviving phase space of the beam and the time resolution were simulated with the Monte-Carlo code MOCADI using an isochronous setting of the CR with $\gamma_t$=1.67. In the calculations $10^4$ ions of one species (m/q=3.14) were circulated for 100 turns in the CR. At each turn the ions pass through the two TOF detectors, which were included in the simulations as two round apertures with a carbon foil of 24 $\mu$g/cm$^2$. Figure 1 indicates the phase space for the case of full emittance ($+$) and after inserting foils with Ø80 mm after 1 ($\times$) and 100 turns ($\star$), as well as for Ø40 mm foils after 100 turns ($\circ$).

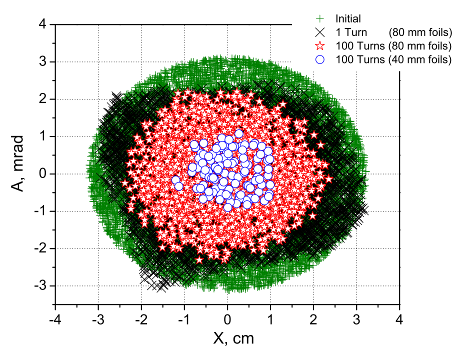


Figure 1: Beam emittance after 100 turns circulation with both TOF detectors in the CR.

These results show that the currently used foil diameter of 40 mm in the ESR TOF detector is too small to store enough ions in the CR for several turns and that larger foil diameters are needed. The time resolution for this emittance was investigated in the simulations as well. With corrections it can reach dT/T $\sim 4{\cdot}10^{-7}$ over 100 turns for this m/q.

## Dual TOF Detector System Design

According to the results from the CR simulations a first design of a dual TOF detector system has been developed, which has an active area that is 4 times larger than in the TOF detector used in the ESR (Fig. 2). The increase of the aperture diameter leads to a larger total detector geometry. In the new design of the detector the electrodes which provide the electric field were optimized in extensive simulations to yield an even better detection efficiency from currently 78% up to 98%. Larger timing uncertainties due to longer path lengths for the secondary electrons can be compensated by increasing the transport energy of the secondary electrons from the foil to the MCP detectors [4]. With this compensation the simulated timing accuracy for the presently used ESR detector and the new design is approximately 40 ps.

Timing investigations of a new anode design for the MCP detectors have also been performed and further improvements for the new design are underway.

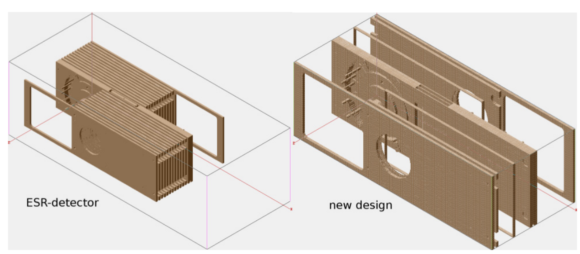


Figure 2: Comparison between the dimensions of the ESR-detector (left) and the new design (right). For the new IMS detector in the CR at FAIR a larger acceptance of the detector is needed and therefore the diameter of the carbon foil in the center of the detector will be increased.

## References

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