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Geometric Optimization of Toroidal Ion Trap Based on Electric Field Analysis and SIMION Simulation

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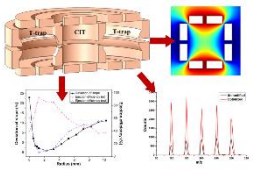
Graphical Abstract



Highlights:

- By combining electric field analysis and SIMION simulation, an optimized T-trap structure was obtained with uniform electric field and directional ion excitation ability.
- A high correlation was found between the electric field gradient distribution in the trap and the ion emission characteristics, and it can be used to implement structure optimization of asymmetric ion trap analyzers.

Abstract: The toroidal-cylindrical ion trap (TCIT) is a small multi-function tandem ion trap analyzer with a simple structure and a compact design. The asymmetric structure of the out toroidal ion trap (T-trap) confers the in-trap region with a non-uniform electric field distribution, particularly when a plate ring electrode is used. To optimize the electric field distribution in the trap, the shapes of the toroidal electrodes were modified to compensate for the electric field. For this purpose, we developed a simple simulation-based method for evaluating the optimized asymmetric structure of the ion trap electrode. Specifically, static electric field distribution in the trap was acquired using COMSOL software and then simply analyzed, while the SIMION simulation platform was adopted to characterize both the ion motion and the performance of the T-trap with an modified structure.