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Experimental observation of the effects of translational and rotational electrode misalignment on a planar linear ion trap mass spectrometer

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Miniaturization of ion trap mass analyzers poses several challenges to good performance. At smaller sizes, electrode misalignment has a greater effect on the accuracy of electric fields, and consequently, on mass resolution. Sensitivity is also affected at small sizes, and is related to misalignment if ion ejection efficiency is compromised by the electrode misalignment. The two-plate linear ion trap (LIT), recently demonstrated in our lab, is an ideal candidate to study the effects of electrode misalignment at the miniature scale because of the simplicity of alignment, having only six degrees of freedom (three rotational and three translational) between the two patterned plates. Glass plates were lithographically patterned with aluminum lines as electrodes. High precision motorized actuators were used to test electrode misalignment on five of the six degrees of freedom. Samples tested includes a mixture of toluene and deuterated (D8) toluene and a mixture of xylenes. One plate was fixed while the other plate was adjusted along each degree of freedom. The five degrees of freedom were labeled: x, y, z, pitch and yaw. Experimental results were compared to previously reported simulations using SIMION. The different degrees of freedom presented different contributions to the trapping performance. Pitch had the greatest impact on mass resolution and intensity at different pitch angles. Small deviations were found with x-displacement as well as with z-displacement; however, x-displacement had the greatest effect on ion ejection. Y-displacement had the greatest contribution on the ion detection efficiency. Finally, yaw had an effect degrading mass resolution.

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