Integrated Ion Optics Design

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Introduction: This study aims the optimization and sensitivity analysis of an existing device. A Secondary Ion Mass Spectrometer (SIMS) device is to be equipped with a high power laser in order to increse sputtering speed. The modified device must be capable of handling the increased level of contamination and energy spread of sample ions. The impact of geometry imperfections due to production and assembly was also examined.

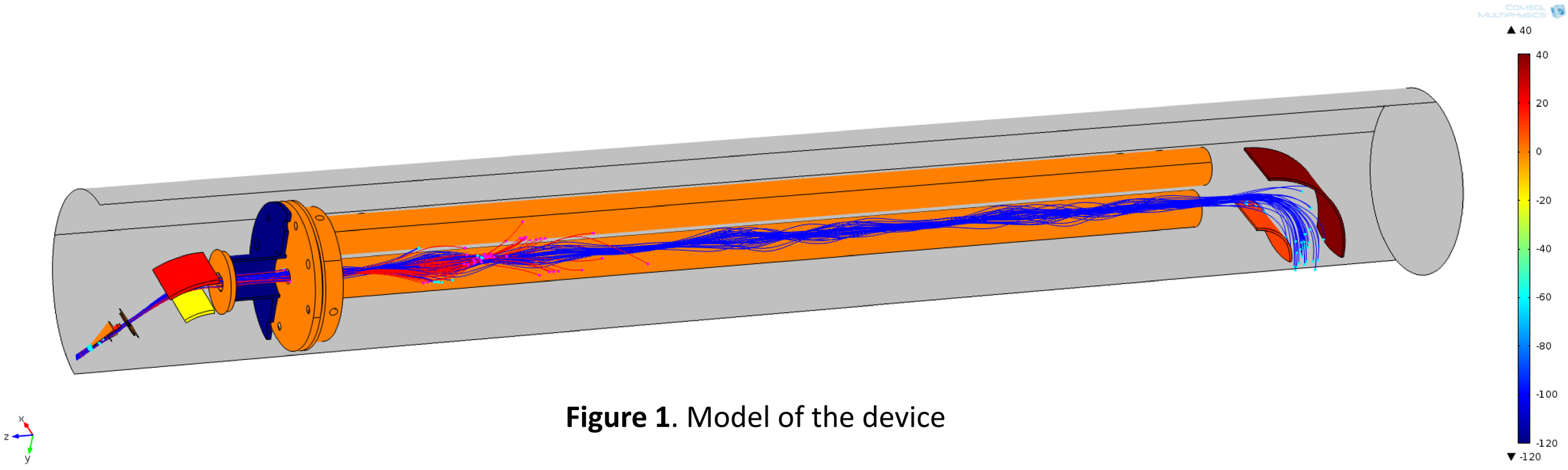
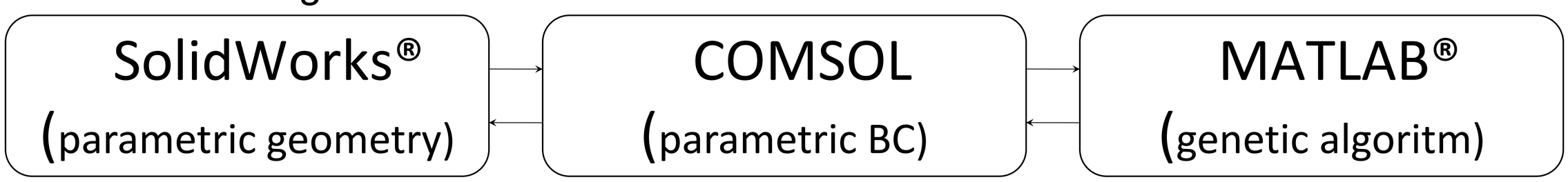


Figure 1. Model of the device

Computational Methods: The model geometry was prepared in SolidWorks®. For some components parametric geometry properties (size, position, clearances), and imperfections (rotation and displacement) were added for later use. The boundary conditions were set up in COMSOL Multiphysics®.
For the optimization study, the LiveLink™ for MATLAB® was used to supervise the COMSOL model. The optimization method was a Genetic Algorithm realized in MATLAB®. For each test run, the MATLAB® script generated a parameter set, consisting geometry and BC modifications, according to a Genetic Algorithm.
The sensitivity study was done by introducing some random imperfections in the model geometry and examine the negative impact on the ion transmission.



Results and conclusions: The geometric optimization increased the transmission by 40%, although all electrodes suffered minor modifications except for the last energy filter. Practical considerations tells us only to modify that particular ion optics. Sensitivity analysis resulted less than 15% loss for reasonable(0.1mm) production tolerances. Preliminary measurements on the device gives good agreement (less than 10% error) between the model and the device, although only the electrode potentials were tested.

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