The current-in-plane tunneling technique (CIPT) has been a crucial tool in the development of magnetic tunnel junction stacks suitable for magnetic random access memories (MRAM) for more than a decade. The MRAM development has now reached the maturity to make the transition from the R&D phase to the pilot production phase. This will require an improvement in the repeatability of the CIPT metrology technique. Here, we present an analytical model that can be used to simulate numerically the repeatability of a CIPT measurement for an arbitrary MTJ stack prior to any CIPT measurement. The model describes mathematically the main sources of error arising when a micro multi-electrode probe is used to perform a CIPT measurement. The numerically simulated repeatability values obtained on four different MTJ stacks are verified by experimental data and the model is used to optimize the choice of electrodes on a multi-electrode probe to reach up to 36% improvement on the repeatability for the resistance area product and the tunneling magnetoresistance measurement, without any hardware modification.