



Generalized Image Charge Method

Quick Start

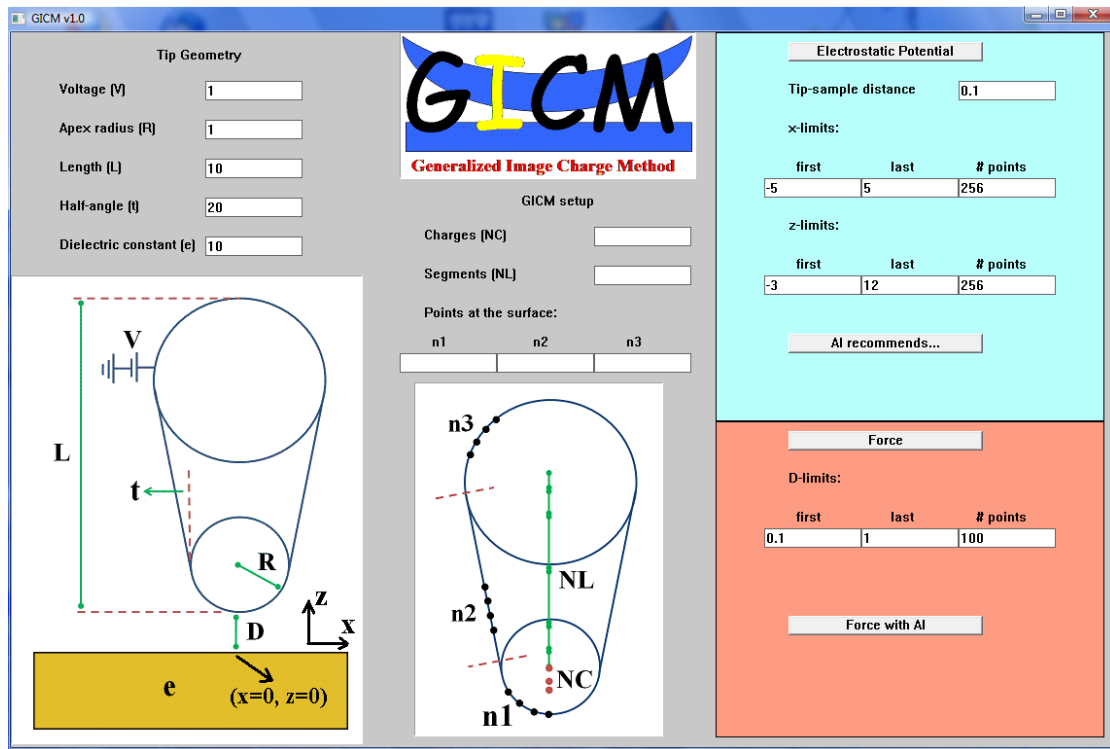
winGICM version 1.0

Quick Start

In this quick start tutorial we will guide you to obtain an equipotential distribution and Force vs Distance curve using the Artificial Intelligence Assistant (AIA) and the WSxM software.

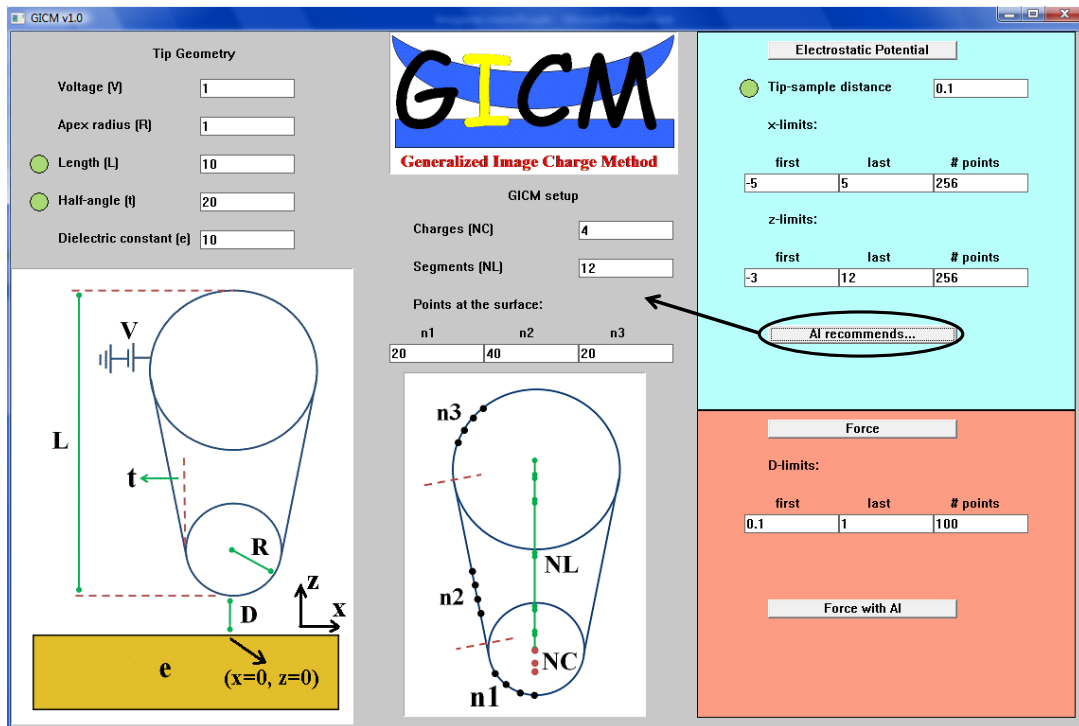
1. Open the winGICM application

We will use the winGICM initial values (shown in the figure). There are not initial values for the GICM setup since they can be easily obtained with the AIA. If we want to use real units, the distances must be considered nanometers, the voltage Volts and the dielectric constant normalized to ϵ_0 . The units are not explicitly shown in the interface because the winGICM calculates the magnitudes in both real and normalized units. The winGICM initial values do not correspond to a realistic Electrostatic Force Microscopy setup. We use these values here because they generate fine-looking equipotential and force curves that are adequate for a tutorial.



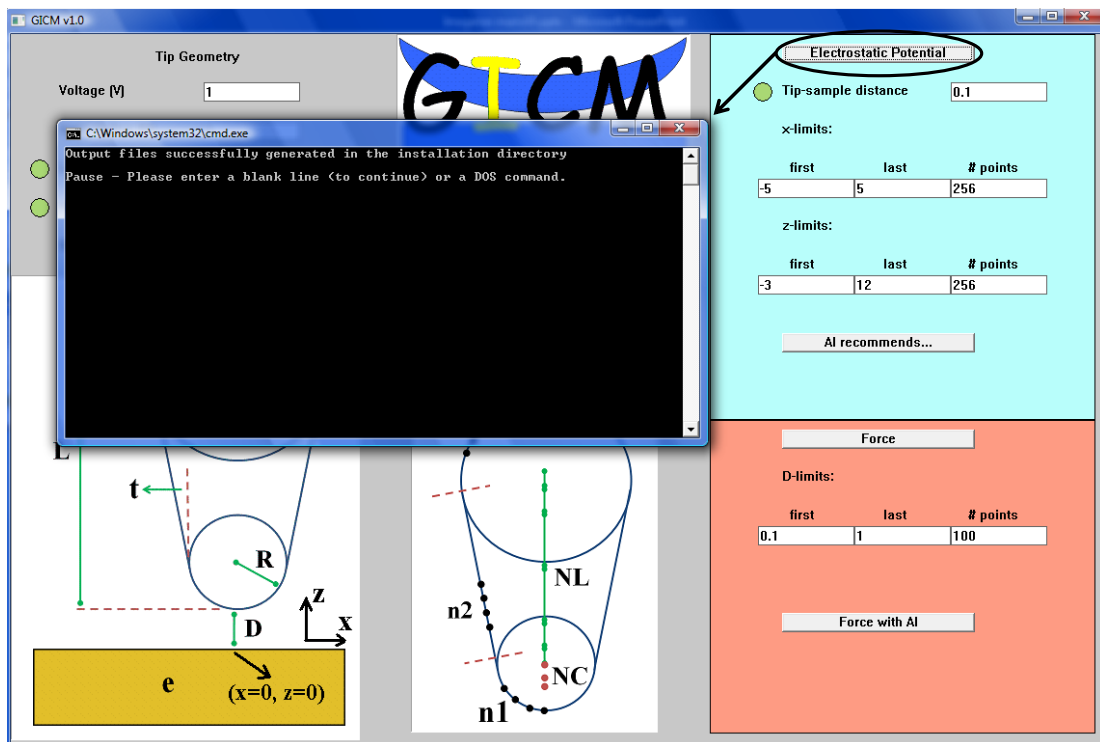
2. Push the AI recommends button

To obtain the AIA estimation, we must click on the *AI recommends* button shown in the figure. After doing it, the estimated values for the GICM setup appear in the graphic interface. It also shows several green circles showing that the parameters are within the limits that the AIA is able to estimate. For example, if we try to use a 60° half-angle, a red circle appears near to it and the AIA does not make any estimation. Changing the half-angle value again to 20°, we recover the original situation. It is a good moment now to try several setups and use the AIA to see the different estimations. At the end, we must recover the original setup to continue with the tutorial.



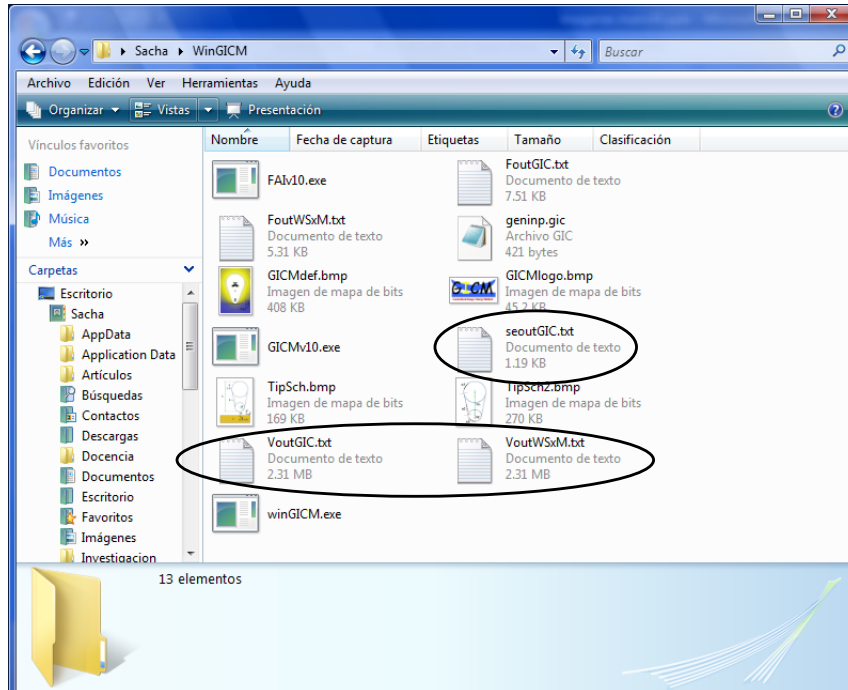
3. Calculate the electrostatic potential

Once we have obtained the GICM setup values, we can calculate the electrostatic potential clicking on the *Electrostatic Potential* button shown in the figure. Then, a new window appears saying that the output files have been generated in the installation directory. Before we continue, we must enter a blank line or a DOS command. If not, the output files may not be correctly generated.



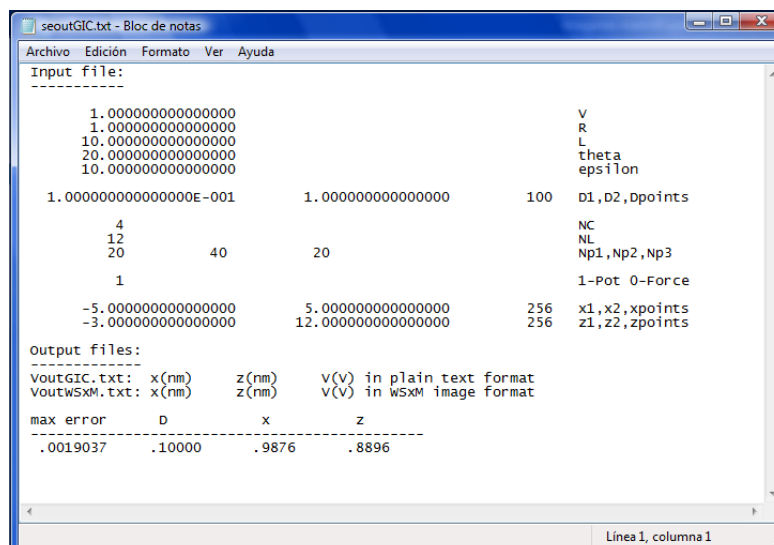
4. Locate the output files

Three new files have been generated in the installation directory: setoutGIC.txt, VoutGIC.txt and VoutWSxM.txt. If these files already exist, the winGICM rewrites them when the electrostatic potential is calculated again.



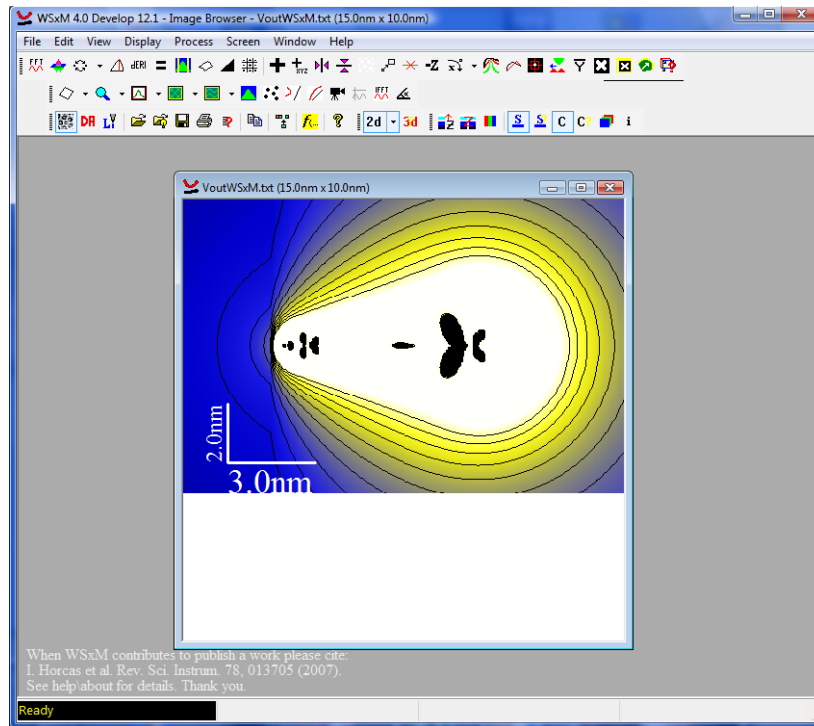
5. Check the setoutGIC.txt file.

It is important to be sure that the equipotential distribution have been correctly generated. The information about the winGICM performance is shown in setoutGIC.txt. First, it shows the Input File that has been read by the GICM algorithm. Second, it gives information about the output files that have been generated during the execution. Finally, it shows the maximum electrostatic potential error at the tip surface, the tip sample distance and the point where it was located. In this case, the maximum error is 0.0019037V at $x=0.9876$ and $z=0.8896$. If we are using real units, all the distances are nanometers.



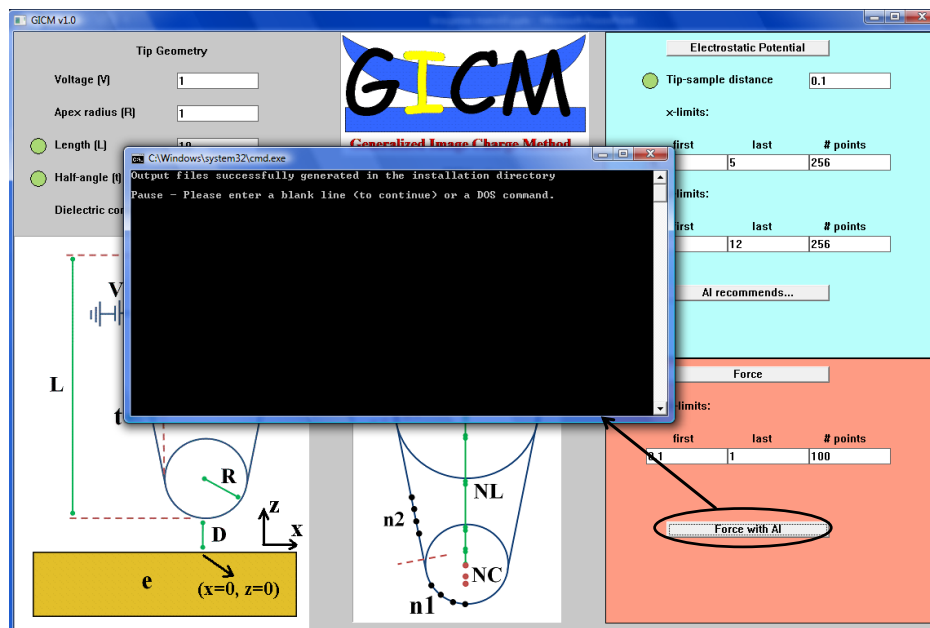
6. Load the VoutWSxM.txt file with the software WSxM

The VoutWSxM.txt file can be directly read by the Nanotec S.L. software WSxM. In the image, it is shown the electrostatic potential distribution obtained with the previous configuration. A series of contour lines have been added to the image. To obtain the correct electrostatic potential distribution, no plane adjustment must be made by the WSxM.



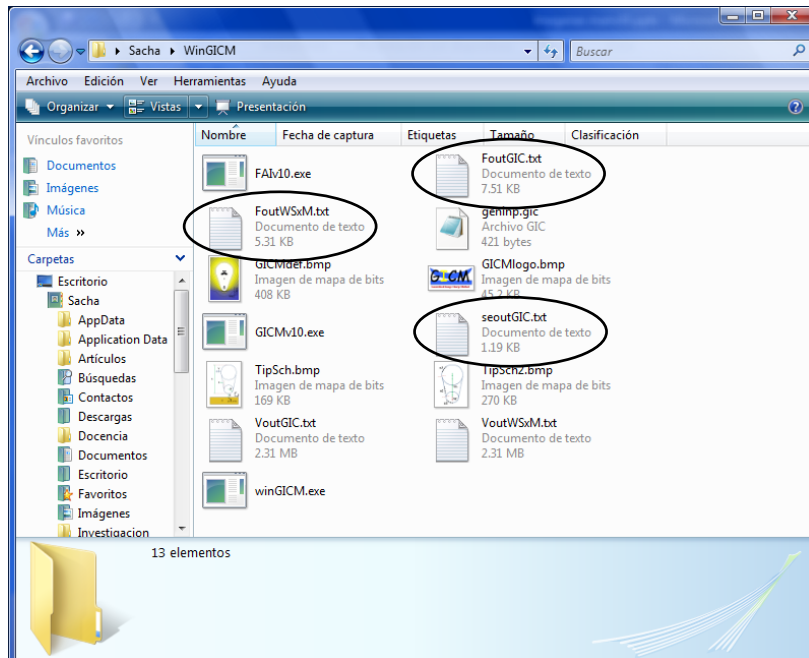
7. Calculate the electrostatic force with the AIA

To calculate the electrostatic force, using the AIA, we must click on the *Force with AI* button as shown in the figure. The program will generate again the window that we saw on step 3. Again, we must enter a blank line or a DOS command.



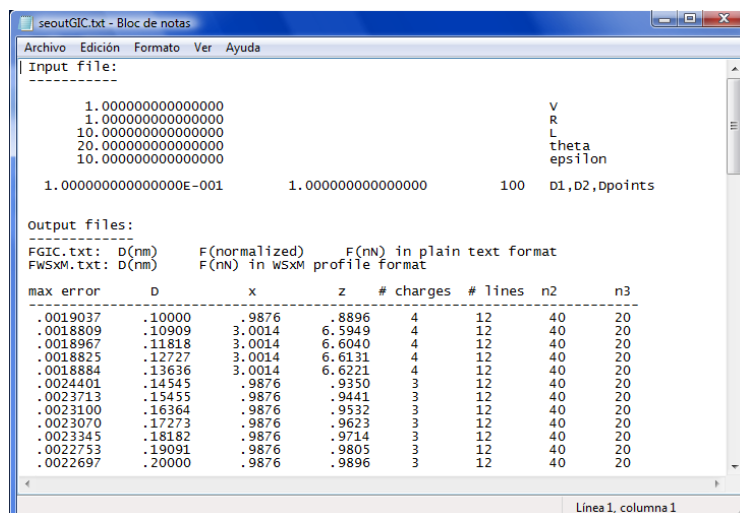
8. Locate the output files

In this case, the output files that have been generated/modified are setoutGIC.txt, FoutGIC.txt and FoutWSxM.txt. The three files are located in the installation directory. If any of them already existed, it has been rewritten (we already know that, at least setoutGIC.txt existed since we generated it at step 3).



9. Check the setoutGIC.txt file

The setoutGIC.txt file has been modified and it gives different information now. It gives now the maximum error for any tip-sample distance that was calculated for the Force vs Distance curve. SetoutGIC.txt also gives information about the GICM configuration used at any time. The number of points at the first region is not shown since it is always $n1=20$ when the AIA is used. It is worth noting that, clicking on the *Force with AI* button, the GICM does not take into account the parameters placed in the GICM setup section of the graphic interface. The Force is calculated with the configuration estimated by the AIA for every distance (the one shown in the setoutGIC.txt file).



10. Load the FoutWSxM.txt file with the software WSxM

We can now load the FoutWSxM.txt file with WSxM as we did on step 6. If we still keep the equipotential distribution in the WSxM main window, the final result should be as shown in the figure. At this time, we can try to calculate the force without using the AIA assistant and compare the results with the ones obtained before. When the AIA is not used (*Force* button), the geometry used for the whole range of tip-sample distances is the one from the GICM setup section. For the geometry used here, it will work fine for small tip-sample distances. However, it will generate very bad results for bigger distances.

