Instruction to run the Langmuir Probe System:

1. Set the Voltage Generator to 10 Hz, triangular wave with "1" for the knob.

2. Voltage Generator: sync out goes to 'EXT' Picoscope

3. 'HI' from Picoscope is connected to a "T" connection with one going to "Channel A" of the Picoscope, and the other one goes to the "voltage programming input" of the Differential Amplifier. BNC connected to red and black wires.

4. Differential Amplifier Setting: voltage control: off , mode: to the left, current control: off

5. Then another black and red wire from the 'common black' and output (red) of the voltage generator goes to the BNC which is connected to the bottom of the resistor box (330ohm). (next to sense and below ground). It does not go into the probe. That's the signal input from the voltage generator.

6. Resistor box: another BNC cable from the bottom of the resistor box goes to "+" of the Differential Amplifier.

7. The second BNC output from the top of the resistor box goes into the "-" of the Differential Amplifier

8. The BNC connects the 'Output Amplifier' (back of the Differential Amplifier) to channel B of the picoscope.

How about the Setting of the Picoscope?

Install Picoscope 6 - PC Oscilloscope software version: 6.14.10.4759
It must be one of the 6000 series. Use the following link to download it:
https://www.picotech.com/downloads

Setting:

1. Trigger: Repeat and choose External
2. Set the pre-trigger to 0%
3. Set the number of samples to 100k
4. Resolution to 15 bits, not 16 bits is only for one channel to no
5. Play with the voltage range instead of auto - left top
6. Set B and A to Auto
7. Click on A and B, and activate low pass filtering for both
8. Use DC offset - waveform is inversed it should be -10 to 30 - moving it up and down

9. Add average. Go to tools> Math channels> Create>Next>Advanced> Buffered> Click on Asverage function> Click on A> Next> Choose color> Override the automatic range selection> -5 to 5> Finish
   Do this for Other channel
   Check both average A and Average B> ok

This command notifies you when it stops capturing and give you an alarm to save the averaged waveform.

1. tools>alarm>event-buffers full> add> action:stop capture> apply>ok

Troubleshooting the Probe:

A Langmuir probe at its simplest form is a wire that is inserted into the plasma and electrically biased to draw electron and ion current. From the second derivative of the current-voltage characteristic, we can obtain plasma properties following Druyvestyn method. These parameters are electron/ion densities, electron temperature, and most importantly, electron energy distribution/probability function. So, the signal has to be very clean with a high signal to noise ratio since we are taking the second derivative of it. When the probe is inserted into the plasma, a sheath forms around it. We excite plasma at 13.56 MHz. Therefore, we have oscillation on probe sheath. Rf oscillations cause rf potential to build up on probe tip sheath. We need a compensating circuit to combat these oscillations.We need to find a way to increase signal to noise ratio and have a way to combat RF harmonics. We need to create a notch filter at the first, second, and third harmonics since they introduce noise to our signal. An inductor resonating at 13.56 MHz can block the first harmonic.

We also want the probe tip to follow the voltage oscillations. So, we connect a large auxiliary electrode to the capacitor. Since it is larger than the probe tip, it can see more fluctuations. Capacitance exists between the electrode and the plasma. So, the capacitance of the capacitor we choose should be higher than the capacitance we can shunt (follow). So, this way we force the probe tip to follow the voltage oscillation.

How do we make sure the inductor is working?

We take the FFT of Channel A and Channel B to see the frequency spectrum. It is not choked, we will see spikes at first harmonic frequency which is 13.56 MHz. Therefore, the inductor needs to be changed.

How do we make sure the capacitor is working?

We simply look at the current-voltage data (Channel A and B). If the voltage has a lot of noise, then the capacitor needs to be changed.