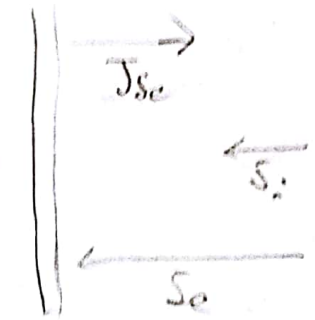
2016 I : Q2 Diagnostics

a.) Floating potential occurs when all probe currents are balanced:

$\sum J = 0$:



A high secondary electron coefficient on a probe tip means that an electron current will develop leaving the probe. To maintain current balance, a smaller incoming ion current is needed. The probe becomes less negatively biased, so the floating potential is pushed up towards the plasma potential.

b.) At floating potential with $\delta_e = 0$, current balance gives

$J_e = -J_i$ at non-zero δ_e we have $(1-\delta_e) J_e = -J_i$

with $\delta_e = 0.5$, we have $0.5\, J_e = -J_i$

If $\delta_e = 0.9$, we have $0.1\, J_e = -J_i$

c.) $J_e \sim \exp\left(\frac{-e(V_p - V)}{kT_e}\right)$ $\quad J_i \sim$ const (for $V < V_p$)

$$\Rightarrow V_p - V \sim \frac{kT_e}{e} \ln\left(\left|\frac{J_i}{J_e}\right| \frac{1}{1-\delta_e}\right), \quad \left|\frac{J_i}{J_e}\right| < 1$$

So in order to directly measure the space potential, we need $V = V_f$. $\Rightarrow \left(\left|\frac{J_i}{J_e}\right| \frac{1}{1-\delta_e}\right) = 1 \Rightarrow \delta_e = 1 - \left|\frac{J_i}{J_e}\right|$

$\left|\frac{J_i}{J_e}\right| \sim \sqrt{\frac{m_e}{m_i}} \sim \frac{1}{40}$ so need $\delta_e \sim 0.98$

If we don't have such a material, we can just fit a curve to a few points with lower δ_e. (Or use an emissive probe to artificially increase δ_e)