Swarm Probes Simulation Results

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For $V < 0$

$$\begin{aligned} I_{net} &= \pi a^2 qn \left(\frac{2kT_i}{\pi m_i}\right)^{1/2} \left[e^{-x_{id}} + \left(1 + 2x_{id} - \frac{2qV}{kT_i}\right) \frac{\sqrt{\pi}}{2} \frac{\mathrm{erf}(x_{id})}{x_{id}}\right] \\ &- \pi a^2 qn \left(\frac{2kT_e}{\pi m_e}\right)^{1/2} \left\{ \frac{x_{ed} + x_{em}}{2x_{ed}} e^{-(x_{ed}-x_{em})^2} + \frac{x_{ed} - x_{em}}{2x_{ed}} e^{-(x_{ed}+x_{em})^2} \right. \\ &+ \left. \left[\frac{1}{2} + x_{ed}^2 - \frac{qV}{kT_e}\right] \frac{\sqrt{\pi}}{2} \frac{\mathrm{erf}(x_{ed} - x_{em}) + \mathrm{erf}(x_{ed} + x_{em})}{x_{ed}} \right\}, \end{aligned} \tag{1}$$

and for $V > 0$

$$\begin{aligned} I_{net} &= \pi a^2 qn \left(\frac{2kT_i}{\pi m_i}\right)^{1/2} \left\{ \frac{x_{id} + x_{im}}{2x_{id}} e^{-(x_{id}-x_{im})^2} + \frac{x_{id} - x_{im}}{2x_{id}} e^{-(x_{id}+x_{im})^2} \right. \\ &+ \left. \left[\frac{1}{2} + x_{id}^2 - \frac{qV}{kT_i}\right] \frac{\sqrt{\pi}}{2} \frac{\mathrm{erf}(x_{id} - x_{im}) + \mathrm{erf}(x_{id} + x_{im})}{x_{id}} \right\} \\ &- \pi a^2 qn \left(\frac{2kT_e}{\pi m_e}\right)^{1/2} \left[e^{-x_{ed}} + \left(1 + 2x_{ed} - \frac{2qV}{kT_e}\right) \frac{\sqrt{\pi}}{2} \frac{\mathrm{erf}(x_{ed})}{x_{ed}}\right], \end{aligned} \tag{2}$$

$$x_d = \frac{v_d}{\sqrt{2kT/m}}, \tag{3}$$

$$x_m = \sqrt{\frac{qV}{kT}}, \tag{4}$$

$$n = \frac{dI_{ion}}{dV} \left(\pi a^2 \frac{2q^2}{v_d} \sum_{j=1}^{N} \frac{n_j}{n_{tot}} \frac{1}{m_j} \mathrm{erf}\left(\frac{v_d}{\sqrt{2kT_i/m_j}}\right)\right)^{-1}, \tag{5}$$

$$I_{ion} = \pi a^2 qnv_d \left(1 - \frac{2qV}{16 m_p v_d^2}\right), \tag{6}$$

$$n = \frac{dI_{ion}}{dV} \left(\pi a^2 \frac{2q^2}{16 m_p v_d}\right)^{-1}. \tag{7}$$

$$T_e = \frac{I_{ret} - I_{ion} - d_{ion}(V_{ret} - V_{ion})}{d_{ret} - d_{ion}}, \tag{8}$$

n $10^{10}m^{-3}$	T_e eV	T_i eV	m_{eff} amu	λ_D mm	V_p V	I_{sim} nA	δI_{sim} %	$\epsilon_{I_{OML}}$ %	$\epsilon_{I_{OML_{16}}}$ %
3.16	0.070	0.070	7.4	11.1	-3.5	5.103	0.3	2.2	34.8
3.16	0.070	0.070	7.4	11.1	-4.5	5.988	0.4	2.2	37.8
3.16	0.070	0.070	7.4	11.1	-5.5	6.886	0.3	2.4	40.1
10.00	0.070	0.068	5.9	6.2	-3.5	18.608	0.3	1.9	43.4
10.00	0.070	0.068	5.9	6.2	-4.5	22.232	0.5	2.5	47.0
10.00	0.070	0.068	5.9	6.2	-5.5	25.703	0.3	2.3	49.2
31.6	0.070	0.070	4.1	3.5	-3.5	74.462	0.4	1.4	55.2
31.6	0.070	0.070	4.1	3.5	-4.5	90.428	0.6	1.8	58.8
31.6	0.070	0.070	4.1	3.5	-5.5	106.059	0.4	1.8	**61.1**
63.2	0.082	0.079	13.7	2.7	-3.5	73.020	0.7	2.0	8.8
63.2	0.082	0.079	13.7	2.7	-4.5	83.467	**1.1**	3.2	10.7
63.2	0.082	0.079	13.7	2.7	-5.5	92.387	0.7	2.5	10.7
1.00	0.156	0.116	8.3	29.4	-3.5	1.515	0.4	3.1	30.5
1.00	0.156	0.116	8.3	29.4	-4.5	1.770	0.4	3.5	33.4
1.00	0.156	0.116	8.3	29.4	-5.5	2.032	0.2	**4.2**	35.8
3.16	0.140	0.113	11.4	15.7	-3.5	3.999	0.3	2.3	16.8
3.16	0.140	0.113	11.4	15.7	-4.5	4.588	0.4	2.7	18.8
3.16	0.140	0.113	11.4	15.7	-5.5	5.175	0.3	3.1	20.3
10.0	0.140	0.112	13.0	8.8	-3.5	11.902	0.4	2.4	11.5
10.0	0.140	0.112	13.0	8.8	-4.5	13.520	0.5	2.6	12.8
10.0	0.140	0.112	13.0	8.8	-5.5	15.176	0.4	3.1	14.0
31.6	0.140	0.089	15.9	5.0	-3.5	34.381	0.5	2.3	3.2
31.6	0.140	0.089	15.9	5.0	-4.5	38.595	0.7	2.6	3.4
31.6	0.140	0.089	15.9	5.0	-5.5	42.745	0.5	2.7	3.5
3.16	0.210	0.120	12.6	19.2	-3.5	3.816	0.3	2.8	12.8
3.16	0.210	0.120	12.6	19.2	-4.5	4.356	0.5	3.4	14.5
3.16	0.210	0.120	12.6	19.2	-5.5	4.883	0.3	3.6	15.6
10.0	0.220	0.107	11.3	11.0	-3.5	12.761	0.3	2.5	17.4
10.0	0.220	0.107	11.3	11.0	-4.5	14.636	0.5	2.9	19.4
10.0	0.220	0.107	11.3	11.0	-5.5	16.521	0.3	3.3	21.0
10.0	0.280	0.121	16.0	12.4	-3.5	10.727	**1.1**	1.1	1.9
10.0	0.280	0.121	16.0	12.4	-4.5	12.093	1.0	1.7	2.5
10.0	0.280	0.121	16.0	12.4	-5.5	13.553	0.3	3.0	3.7

Table 1: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate an overestimation while negative signs an underestimation.

n $10^{10}m^{-3}$	T_e eV	T_i eV	m_{eff} amu	λ_D mm	ϵ_{n_I} %	δn_I %	ϵ_n %	$\epsilon_{n_{16}}$ %	$\delta_{n-n_{16}}$ %
3.16	0.070	0.070	7.4	11.1	2.2	0.4	3.1	55.4	1.4
10.00	0.070	0.068	5.9	6.2	2.5	0.5	3.3	64.6	1.5
31.6	0.070	0.070	4.1	3.5	1.8	0.6	2.6	**74.9**	1.7
63.2	0.082	0.079	13.7	2.7	3.2	**1.1**	4.3	18.0	4.3
1.00	0.156	0.116	8.3	29.4	3.5	0.4	7.2	51.4	1.5
3.16	0.140	0.113	11.4	15.7	2.7	0.5	5.8	32.4	1.6
10.0	0.140	0.112	13.0	8.8	2.6	0.7	5.8	23.2	2.2
31.6	0.140	0.089	15.9	5.0	2.6	0.5	4.3	5.0	3.2
3.16	0.210	0.120	12.6	19.0	**3.4**	0.5	6.6	25.6	1.8
10.0	0.220	0.107	11.3	11.0	2.9	0.5	5.7	33.1	1.8
10.0	0.280	0.121	16.0	12.4	1.7	1.0	**10.3**	10.6	**4.4**

Table 2: Relative errors in the inferred density calculated from probe simulations results. $\epsilon_{I_{pic}}$ are the relative errors when Eq. 1 is used to infer density. ϵ_n and ϵ_n, correspond to relative errors in inferred density when Eq. 5 and 7 are used respectively. δ_{n_I} and δ_n represent the relative uncertainties in their respective inferred densities. Positive errors indicate that the calculated density is overestimated while negative signs refer to an underestimation. In all cases, the ram velocity is 7673 m/s.

n $10^{10}m^{-3}$	Te eV	Ti eV	m_{eff}	λ_D mm	$v_\perp$ m/s	V_f^{Swarm} mV	V_f^{LP} mV	V_f^{OML} mV
3.16	0.070	0.070	7.35	11.06	7673	-201	-205	-213
10.00	0.070	0.068	5.85	6.22	7673	-195	-203	-211
31.6	0.070	0.070	4.10	3.50	7673	-194	-198	-209
63.2	0.082	0.079	13.71	2.68	7673	-223	-209	-259
1.00	0.156	0.116	8.29	29.36	7673	-513	-504	-520
3.16	0.140	0.113	11.40	15.65	7673	-454	-451	-469
10.0	0.140	0.112	12.99	8.80	7673	-443	-456	-471
31.6	0.140	0.089	15.88	4.95	7673	-437	-457	-474
3.16	0.210	0.120	12.57	19.16	7673	-719	-706	-736
10.0	0.220	0.107	11.28	11.03	7673	-752	-746	-770
10.0	0.280	0.121	15.96	12.44	7673	-990	-990	-1017

Table 3: Floating Potentials for several configurations.

SWARM LP ION SATURATION CURRENT C01

n	Te	Ti	m_{eff}	λ_D	v_d	
$3.16 \times 10^{10} m^{-3}$	0.070 eV	0.070 eV	7.7 amu	11.1 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.201	-2.701	LP_1	4.311	3.1	32.1	1.3
-0.201	-2.701	LP_2	4.375	4.5	33.1	1.2
-0.201	-2.701	LP_A	4.343	3.8	32.6	0.9
-0.201	-3.701	LP_1	5.229	4.1	36.7	1.0
-0.201	-3.701	LP_2	5.333	5.9	37.9	1.0
-0.201	-3.701	LP_A	5.282	5.0	37.3	0.7
-1.0	-3.5	LP_1	4.468	-8.5	27.6	1.6
-1.0	-3.5	LP_2	4.589	-5.6	29.5	1.6
-1.0	-3.5	LP_A	4.529	-7.0	28.6	1.1
-1.0	-4.5	LP_1	5.324	-6.8	32.0	1.2
-1.0	-4.5	LP_2	5.412	-5.1	32.1	1.2
-1.0	-4.5	LP_A	5.368	-5.9	32.6	0.9
-2.0	-4.5	LP_1	4.453	-27.7	18.7	1.2
-2.0	-4.5	LP_2	4.507	-26.2	19.7	1.2
-2.0	-4.5	LP_A	4.480	-26.9	19.2	0.9
-2.0	-5.5	LP_1	5.134	-27.1	22.0	1.0
-2.0	-5.5	LP_2	5.230	-24.8	23.4	1.0
-2.0	-5.5	LP_A	5.182	-25.9	22.7	0.7

Table 4: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.6\%$

SWARM LP ION SATURATION CURRENT C02

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10} m^{-3}$	0.070 eV	0.068 eV	5.9 amu	6.2 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.195	-2.695	LP_1	15.658	3.9	40.9	1.6
-0.195	-2.695	LP_2	15.770	4.6	41.4	1.6
-0.195	-2.695	LP_A	15.714	4.3	41.1	1.1
-0.195	-3.695	LP_1	19.038	3.5	45.0	1.3
-0.195	-3.695	LP_2	19.439	5.5	46.1	1.3
-0.195	-3.695	LP_A	19.238	4.5	45.6	0.9
-1.0	-3.5	LP_1	17.217	-3.0	40.6	1.9
-1.0	-3.5	LP_2	17.218	-3.0	40.6	2.0
-1.0	-3.5	LP_A	17.218	-3.0	40.6	1.4
-1.0	-4.5	LP_1	20.458	-2.9	44.0	1.5
-1.0	-4.5	LP_2	20.806	-1.2	45.0	1.5
-1.0	-4.5	LP_A	20.632	-2.1	44.5	1.1
-2.0	-4.5	LP_1	18.648	-12.9	38.6	2.5
-2.0	-4.5	LP_2	18.676	-12.9	38.7	2.6
-2.0	-4.5	LP_A	18.665	-12.8	38.6	1.1
-2.0	-5.5	LP_1	21.981	-11.0	42.3	1.6
-2.0	-5.5	LP_2	22.173	-10.0	42.8	1.5
-2.0	-5.5	LP_A	22.077	-10.5	42.6	1.1

Table 5: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.5\%$

SWARM LP ION SATURATION CURRENT C03

n	Te	Ti	m_{eff}	λ_D	v_d	
$31.6 \times 10^{10} m^{-3}$	0.070 eV	0.070 eV	4.1 amu	3.5 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.195	-2.695	LP_1	60.311	1.0	51.2	1.4
-0.195	-2.695	LP_2	60.605	1.4	51.4	1.3
-0.195	-2.695	LP_A	60.458	1.2	51.3	1.0
-1.0	-3.5	LP_1	69.054	-4.1	52.8	2.0
-1.0	-3.5	LP_2	67.559	-6.4	51.8	2.0
-1.0	-3.5	LP_A	68.306	-5.2	52.3	1.4
-1.0	-4.5	LP_1	82.966	-4.8	56.0	1.1
-1.0	-4.5	LP_2	83.901	-3.6	56.5	1.0
-1.0	-4.5	LP_A	83.434	-4.2	56.3	0.7
-2.0	-4.5	LP_1	76.356	-13.9	52.2	1.4
-2.0	-4.5	LP_2	77.879	-11.6	53.2	1.4
-2.0	-4.5	LP_A	77.118	-12.7	52.7	1.0
-2.0	-5.5	LP_1	90.890	-12.2	55.6	1.1
-2.0	-5.5	LP_2	92.448	-10.3	56.3	1.1
-2.0	-5.5	LP_A	91.669	-11.3	56.0	0.8

Table 6: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.1\%$

SWARM LP ION SATURATION CURRENT C04

n	Te	Ti	m_{eff}	λ_D	v_d	
$63.2 \times 10^{10} m^{-3}$	0.082 eV	0.079 eV	13.7 amu	2.7 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.223	-2.723	LP_1	64.079	1.6	7.7	1.9
-0.223	-2.723	LP_2	66.806	5.7	11.5	1.9
-0.223	-2.723	LP_A	65.443	3.7	9.6	1.3
-1.0	-3.5	LP_1	69.716	-0.5	6.5	2.1
-1.0	-3.5	LP_2	71.276	1.7	8.5	2.1
-1.0	-3.5	LP_A	70.496	0.6	7.5	1.5
-1.0	-4.5	LP_1	82.321	3.9	11.4	1.8
-1.0	-4.5	LP_2	80.172	1.3	9.0	1.8
-1.0	-4.5	LP_A	81.246	2.6	10.2	1.3
-2.0	-4.5	LP_1	76.197	-3.9	4.2	2.3
-2.0	-4.5	LP_2	79.652	0.6	8.4	2.2
-2.0	-4.5	LP_A	77.925	-1.6	6.4	1.6
-2.0	-5.5	LP_1	88.760	0.6	9.0	1.9
-2.0	-5.5	LP_2	87.962	-1.4	7.1	1.9
-2.0	-5.5	LP_A	87.861	-0.4	8.1	1.3

Table 7: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 3.0\%$

SWARM LP ION SATURATION CURRENT C05

n	Te	Ti	m_{eff}	λ_D	v_d	
$10^{10}m^{-3}$	0.156 eV	0.116 eV	8.3 amu	29.4 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.513	-3.013	LP_1	1.217	-7.8	20.8	1.3
-0.513	-3.013	LP_2	1.222	-7.4	21.1	1.3
-0.513	-3.013	LP_A	1.220	-7.6	21.0	0.9
-0.513	-4.013	LP_1	1.448	-6.7	25.0	1.1
-0.513	-4.013	LP_2	1.443	-7.1	24.8	1.1
-0.513	-4.013	LP_A	1.446	-6.9	24.9	0.7
-1.0	-3.5	LP_1	1.191	-19.6	14.1	1.4
-1.0	-3.5	LP_2	1.211	-17.7	15.5	1.4
-1.0	-3.5	LP_A	1.201	-18.7	14.8	1.0
-1.0	-4.5	LP_1	1.392	-19.2	17.7	1.1
-1.0	-4.5	LP_2	1.399	-18.5	18.2	1.0
-1.0	-4.5	LP_A	1.396	-18.8	17.9	0.7
-2.0	-4.5	LP_1	1.136	-46.0	-0.8	1.7
-2.0	-4.5	LP_2	1.153	-43.9	0.6	1.7
-2.0	-4.5	LP_A	1.145	-44.9	0.0	1.2
-2.0	-5.5	LP_1	1.300	-45.5	2.5	1.1
-2.0	-5.5	LP_2	1.328	-42.4	4.6	1.1
-2.0	-5.5	LP_A	1.314	-44.0	3.6	0.8

Table 8: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 0.7\%$

SWARM LP ION SATURATION CURRENT C06

n	Te	Ti	m_{eff}	λ_D	v_d	
$3.16 \times 10^{10} m^{-3}$	0.140 eV	0.113 eV	11.4 amu	15.7 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.454	-2.954	LP_1	3.497	-0.2	13.6	1.5
-0.454	-2.954	LP_2	3.545	1.2	14.7	1.5
-0.454	-2.954	LP_A	3.521	0.5	14.2	1.1
-1.0	-3.5	LP_1	3.647	-4.1	11.3	1.5
-1.0	-3.5	LP_2	3.680	-3.2	12.1	1.5
-1.0	-3.5	LP_A	3.663	-3.6	11.7	1.1
-1.0	-4.5	LP_1	4.187	-3.5	13.6	1.2
-1.0	-4.5	LP_2	4.256	-1.8	15.0	1.1
-1.0	-4.5	LP_A	4.222	-2.7	14.3	0.8
-2.0	-4.5	LP_1	3.771	-15.0	4.0	1.9
-2.0	-4.5	LP_2	3.809	-13.8	5.0	1.9
-2.0	-4.5	LP_A	3.790	-14.4	4.5	1.36
-2.0	-5.5	LP_1	4.245	-14.8	5.6	1.2
-2.0	-5.5	LP_2	4.304	-13.2	7.0	1.2
-2.0	-5.5	LP_A	4.275	-14.0	6.3	0.8

Table 9: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.3\%$

SWARM LP ION SATURATION CURRENT C07

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10} m^{-3}$	0.140 eV	0.112 eV	13.0 amu	8.8 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.443	-2.943	LP_1	10.730	2.6	11.0	1.3
-0.443	-2.943	LP_2	10.902	4.2	12.4	1.3
-0.443	-2.943	LP_A	10.816	3.4	11.7	0.9
-1.0	-3.5	LP_1	11.106	-1.6	7.9	2.0
-1.0	-3.5	LP_2	11.518	2.0	11.2	2.0
-1.0	-3.5	LP_A	11.312	0.2	9.5	1.4
-1.0	-4.5	LP_1	12.949	1.3	11.6	1.5
-1.0	-4.5	LP_2	13.3	3.8	13.8	1.4
-1.0	-4.5	LP_A	13.116	2.5	12.7	1.0
-2.0	-4.5	LP_1	12.383	-3.2	7.5	2.2
-2.0	-4.5	LP_2	12.365	-3.4	7.4	2.2
-2.0	-4.5	LP_A	12.374	-3.3	7.4	1.5
-2.0	-5.5	LP_1	13.972	-2.2	9.3	1.4
-2.0	-5.5	LP_2	14.120	-1.1	10.2	1.3
-2.0	-5.5	LP_A	14.046	-1.7	9.8	1.0

Table 10: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 2.2\%$

SWARM LP ION SATURATION CURRENT C08

n	Te	Ti	m_{eff}	λ_D	v_d	
$31.6 \times 10^{10} m^{-3}$	0.140 eV	0.089 eV	15.9 amu	5.0 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.437	-2.937	LP_1	31.629	3.0	3.9	1.5
-0.437	-2.937	LP_2	31.534	2.7	3.6	1.6
-0.437	-2.937	LP_A	31.581	2.9	3.7	1.1
-1.0	-3.5	LP_1	33.473	1.8	2.6	1.7
-1.0	-3.5	LP_2	33.097	0.7	1.5	1.6
-1.0	-3.5	LP_A	33.285	1.2	2.1	1.2
-1.0	-4.5	LP_1	37.917	3.0	3.8	1.7
-1.0	-4.5	LP_2	37.744	2.5	3.3	1.7
-1.0	-4.5	LP_A	37.830	2.7	3.5	1.2
-2.0	-4.5	LP_1	36.316	-1.3	-0.5	1.8
-2.0	-4.5	LP_2	36.057	-2.0	-1.2	1.8
-2.0	-4.5	LP_A	36.187	-1.7	-0.8	1.3
-2.0	-5.5	LP_1	41.0442	0.8	1.6	1.4
-2.0	-5.5	LP_2	40.900	0.5	1.3	1.4
-2.0	-5.5	LP_A	40.972	0.6	1.5	1.0

Table 11: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.1\%$

SWARM LP ION SATURATION CURRENT C09

n	Te	Ti	m_{eff}	λ_D	v_d	
$3.16 \times 10^{10} m^{-3}$	0.210 eV	0.120 eV	12.6 amu	19.2 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.719	-3.219	LP_1	3.481	0.4	10.2	1.5
-0.719	-3.219	LP_2	3.466	0.0	9.8	1.5
-0.719	-3.219	LP_A	3.474	0.2	10.0	1.0
-1.0	-3.5	LP_1	3.514	-2.5	8.0	1.5
-1.0	-3.5	LP_2	3.522	-2.3	8.2	1.5
-1.0	-3.5	LP_A	3.518	-2.4	8.1	1.0
-1.0	-4.5	LP_1	4.059	-0.7	10.8	1.1
-1.0	-4.5	LP_2	4.002	-2.2	9.6	1.2
-1.0	-4.5	LP_A	4.031	-1.4	10.2	0.8
-2.0	-4.5	LP_1	3.621	-12.8	0.1	1.8
-2.0	-4.5	LP_2	3.624	-12.8	0.1	1.8
-2.0	-4.5	LP_A	3.623	-12.8	0.1	1.2
-2.0	-5.5	LP_1	4.067	-12.4	1.5	1.2
-2.0	-5.5	LP_2	4.100	-11.5	2.3	1.2
-2.0	-5.5	LP_A	4.084	-11.9	1.9	0.9

Table 12: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.2\%$

SWARM LP ION SATURATION CURRENT C10

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10} m^{-3}$	0.220 eV	0.107 eV	11.3 amu	11.0 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.752	-3.252	LP_1	11.689	0.3	15.1	1.1
-0.752	-3.252	LP_2	11.884	2.0	16.5	1.1
-0.752	-3.252	LP_A	11.787	1.1	15.8	0.8
-1.0	-3.5	LP_1	12.012	-0.6	14.8	1.7
-1.0	-3.5	LP_2	11.977	-0.8	14.6	1.7
-1.0	-3.5	LP_A	11.995	-0.7	14.7	1.2
-1.0	-4.5	LP_1	13.768	-0.2	16.8	1.2
-1.0	-4.5	LP_2	13.754	-0.3	16.7	1.2
-1.0	-4.5	LP_A	13.761	-0.3	16.8	0.8
-2.0	-4.5	LP_1	13.043	-5.8	12.2	2.1
-2.0	-4.5	LP_2	13.125	-5.2	12.7	2.1
-2.0	-4.5	LP_A	13.084	-5.5	12.5	1.5
-2.0	-5.5	LP_1	14.753	-5.2	14.1	1.4
-2.0	-5.5	LP_2	14.761	-5.2	14.1	1.4
-2.0	-5.5	LP_A	14.757	-5.2	14.1	1.0

Table 13: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.0\%$

SWARM LP ION SATURATION CURRENT C11

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10} m^{-3}$	0.280 eV	0.121 eV	16.0 amu	12.4 mm	7673 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-0.990	-3.490	LP_1	10.583	2.5	3.4	1.3
-0.990	-3.490	LP_2	10.607	2.7	3.7	1.3
-0.990	-3.490	LP_A	10.595	2.6	3.5	0.9
-1.0	-3.5	LP_1	10.616	2.7	3.6	1.8
-1.0	-3.5	LP_2	10.402	0.7	1.6	1.8
-1.0	-3.5	LP_A	10.509	1.7	2.6	1.3
-1.0	-4.5	LP_1	11.948	3.2	4.1	1.3
-1.0	-4.5	LP_2	12.001	3.7	4.6	1.3
-1.0	-4.5	LP_A	11.974	3.4	4.4	0.9
-2.0	-4.5	LP_1	11.482	-0.7	0.3	2.2
-2.0	-4.5	LP_2	11.723	1.4	2.3	2.2
-2.0	-4.5	LP_A	11.603	0.4	1.3	1.6
-2.0	-5.5	LP_1	12.723	-0.5	0.4	1.6
-2.0	-5.5	LP_2	12.787	0.0	0.9	1.6
-2.0	-5.5	LP_A	12.755	-0.3	0.6	1.1

Table 14: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 2.0\%$

SWARM LP ION SATURATION CURRENT C12

n	Te	Ti	m_{eff}	λ_D	v_d	
$3.16 \times 10^{10} m^{-3}$	0.070 eV	0.070 eV	7.4.0 amu	11.1 mm	8173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	5.182	-7.7	29.8	2.2
-1.0	-4.5	LP_2	5.424	-2.9	33.0	2.1
-1.0	-4.5	LP_A	5.303	-5.2	31.4	1.5
-2.0	-5.5	LP_1	5.105	-24.7	21.7	2.1
-2.0	-5.5	LP_2	5.278	-20.6	24.3	2.2
-2.0	-5.5	LP_A	5.192	-22.7	23.0	1.5

Table 15: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 3.9\%$

SWARM LP ION SATURATION CURRENT C13

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10} m^{-3}$	0.070 eV	0.068 eV	5.9 amu	6.2 mm	8173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	20.403	-0.7	43.6	2.6
-1.0	-4.5	LP_2	20.457	-0.4	43.8	2.6
-1.0	-4.5	LP_A	20.430	-0.5	43.7	1.9
-1.0	-5.5	LP_1	21.680	-9.2	41.6	2.6
-1.0	-5.5	LP_2	21.985	-7.6	42.5	2.6
-1.0	-5.5	LP_A	21.832	-8.4	42.1	1.8

Table 16: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 0.8\%$

SWARM LP ION SATURATION CURRENT C14

n	Te	Ti	m_{eff}	λ_D	v_d	
$10^{10}m^{-3}$	0.156 eV	0.116 eV	8.3 amu	29.4 mm	8173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	1.389	-17.8	17.2	1.7
-1.0	-4.5	LP_2	1.399	-18.0	17.8	1.8
-1.0	-4.5	LP_A	1.394	-17.4	17.5	1.2
-2.0	-5.5	LP_1	1.318	-40.8	4.0	2.9
-2.0	-5.5	LP_2	1.309	-41.7	3.4	3.0
-2.0	-5.5	LP_A	1.314	-41.3	3.7	2.1

Table 17: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.0\%$

SWARM LP ION SATURATION CURRENT C15

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10}m^{-3}$	0.280 eV	0.121 eV	16.0 amu	12.4 mm	8173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	12.167	4.8	5.4	3.2
-1.0	-4.5	LP_2	11.810	1.9	2.6	3.2
-1.0	-4.5	LP_A	11.989	3.3	4.0	2.3
-2.0	-5.5	LP_1	12.725	-0.1	0.6	2.1
-2.0	-5.5	LP_2	12.794	0.4	1.1	2.1
-2.0	-5.5	LP_A	12.759	0.2	0.8	1.5

Table 18: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.3\%$

SWARM LP ION SATURATION CURRENT C16

n	Te	Ti	m_{eff}	λ_D	v_d	
$3.16 \times 10^{10} m^{-3}$	0.070 eV	0.070 eV	7.4 amu	11.1 mm	7173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	5.366	-8.5	32.6	1.8
-1.0	-4.5	LP_2	5.360	-8.6	32.5	1.8
-1.0	-4.5	LP_A	5.363	-8.6	32.5	1.3
-2.0	-5.5	LP_1	5.193	-29.4	22.4	2.2
-2.0	-5.5	LP_2	5.167	-30.8	22.0	2.2
-2.0	-5.5	LP_A	5.180	-29.7	22.2	1.6

Table 19: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 0.3\%$

SWARM LP ION SATURATION CURRENT C17

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10} m^{-3}$	0.070 eV	0.068 eV	5.9 amu	6.2 mm	7173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	21.069	-3.0	45.7	2.6
-1.0	-4.5	LP_2	21.591	-0.5	47.0	2.6
-1.0	-4.5	LP_A	21.330	-1.7	46.3	1.8
-2.0	-5.5	LP_1	22.216	-13.7	42.6	2.4
-2.0	-5.5	LP_2	22.428	-12.6	43.1	2.4
-2.0	-5.5	LP_A	22.322	-13.1	42.9	1.7

Table 20: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.7\%$

SWARM LP ION SATURATION CURRENT C18

n	Te	Ti	m_{eff}	λ_D	v_d	
$10^{10}m^{-3}$	0.156 eV	0.116 eV	8.3 amu	29.4 mm	7173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	1.401	-20.5	18.3	1.6
-1.0	-4.5	LP_2	1.410	-19.7	18.8	1.6
-1.0	-4.5	LP_A	1.405	-20.1	18.5	1.1
-2.0	-5.5	LP_1	1.303	-48.6	2.1	2.0
-2.0	-5.5	LP_2	1.322	-46.4	3.5	2.0
-2.0	-5.5	LP_A	1.313	-48.5	2.9	1.4

Table 21: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 1.1\%$

SWARM LP ION SATURATION CURRENT C19

n	Te	Ti	m_{eff}	λ_D	v_d	
$10.0 \times 10^{10}m^{-3}$	0.280 eV	0.121 eV	16.0 amu	12.4 mm	7173 m/s	
V_f	V_p	LP_x	I_{sim}	$\epsilon_{I_{OML}}$	$\epsilon_{I_{OML_{16}}}$	δI_{sim}
V	V		nA	%	%	%
-1.0	-4.5	LP_1	11.850	2.6	3.4	2.4
-1.0	-4.5	LP_2	12.114	4.7	5.5	2.5
-1.0	-4.5	LP_A	11.982	3.7	4.5	1.7
-2.0	-5.5	LP_1	12.573	-2.2	-1.4	2.5
-2.0	-5.5	LP_1	12.907	0.4	1.2	2.5
-2.0	-5.5	LP_1	12.740	-0.9	-0.1	1.7

Table 22: I_{sim} are the ion currents calculated from simulations. $\epsilon_{I_{OML}}$ and $\epsilon_{I_{OML16}}$ are the relative errors in currents from simulations with respect to those predicted with OML theory, Eq. 1 and 6, respectively. $\delta_{I_{sim}}$ is the relative uncertainty in the currents from simulations. Positive errors indicate overestimation while negative signs refer to an underestimation. $\delta_{mesh} = 2.4\%$

INFERRED PLASMA DENSITY FROM SWARM LP

n $10^{10}m^{-3}$	Te eV	Ti eV	m_{eff} amu	λ_D mm	V_f V	LP_x	ϵ_{n_I} %	δ_{n_I} %	ϵ_n %	$\epsilon_{n_{16}}$ %	δ_n %
3.16	0.070	0.070	7.4	11.1	-0.201	LP_1	3.1	1.8	8.7	58.0	8.3
					-0.201	LP_2	4.5	1.8	12.5	59.7	8.0
					-0.201	LP_A	3.8	1.2	10.6	58.9	5.7
					-1.0	LP_1	-8.5	2.2	2.0	54.9	11.4
					-1.0	LP_2	-5.6	2.1	-2.0	53.1	12.0
					-1.0	LP_A	-7.0	1.5	0.0	54.0	8.3
					-2.0	LP_1	-27.7	1.6	-23.0	43.4	10.7
					-2.0	LP_2	-26.2	1.6	-16.0	46.6	10.2
					-2.0	LP_A	-26.9	1.2	-19.4	45.1	7.4
10.00	0.070	0.068	5.9	6.2	-0.195	LP_1	3.9	2.2	1.5	63.9	10.3
					-0.195	LP_2	4.6	2.2	9.2	66.7	9.7
					-0.195	LP_A	4.2	1.6	5.5	65.4	7.0
					-1.0	LP_1	-3.0	2.7	-2.8	62.3	14.2
					-1.0	LP_2	-3.0	2.7	7.2	66.0	12.9
					-1.0	LP_A	-3.0	1.9	2.5	64.2	9.6
					-2.0	LP_1	-12.9	3.1	0.1	63.4	17.6
					-2.0	LP_2	-12.8	3.1	4.8	65.1	16.8
					-2.0	LP_A	-12.8	2.2	2.5	64.2	12.2
31.6	0.070	0.070	4.1	3.5	-1.0	LP_1	-4.1	2.4	-8.3	72.0	11.9
					-1.0	LP_2	-6.4	2.4	7.8	76.2	9.9
					-1.0	LP_A	-5.2	1.7	-0.4	74.3	7.6
					-2.0	LP_1	-13.9	1.9	-3.6	73.2	10.1
					-2.0	LP_2	-11.6	1.9	-3.4	73.3	10.3
					-2.0	LP_A	-12.7	1.4	-3.5	73.3	7.2
63.2	0.082	0.079	13.7	2.7	-1.0	LP_1	-0.5	3.0	28.0	38.3	16.5
					-1.0	LP_2	1.7	2.9	-2.0	12.6	23.3
					-1.0	LP_A	0.6	2.1	15.6	27.6	13.6
					-2.0	LP_1	-3.8	3.1	27.8	38.1	19.0
					-2.0	LP_2	0.6	3.0	-24.1	-6.4	32.4
					-2.0	LP_A	-1.5	2.2	8.7	21.7	16.9

n $10^{10}m^{-3}$	Te eV	Ti eV	m_{eff} amu	λ_D mm	V_f V	LP_x	ϵ_{n_I} %	δ_{n_I} %	ϵ_n %	ϵ_{n16} %	δ_n %
1.00	0.156	0.116	8.3	29.4	-0.513	LP_1	-7.8	1.8	-1.1	47.1	9.7
					-0.513	LP_2	-7.4	1.8	-5.3	44.9	10.0
					-0.513	LP_A	-7.6	1.3	-3.1	46.0	7.0
					-1.0	LP_1	-19.6	1.9	-16.4	39.0	11.1
					-1.0	LP_2	-17.7	1.8	-23.3	35.4	11.8
					-1.0	LP_A	-17.7	1.3	-19.8	37.3	8.1
					-2.0	LP_1	-46.0	2.1	-42.5	25.4	14.8
					-2.0	LP_2	-43.9	2.1	-32.7	30.5	14.0
					-2.0	LP_A	-44.9	1.5	-37.5	28.0	10.2
3.16	0.140	0.113	11.4	15.7	-1.0	LP_1	-4.1	2.0	0.5	28.7	13.6
					-1.0	LP_2	-3.2	2.0	6.7	33.1	12.8
					-1.0	LP_A	-3.6	1.4	3.7	30.9	9.3
					-2.0	LP_1	-15.0	2.3	-13.5	18.6	18.6
					-2.0	LP_2	-13.8	2.4	-8.7	22.1	18.1
					-2.0	LP_A	-14.4	1.7	-11.1	20.4	13.0
10.0	0.140	0.112	13.0	8.8	-1.0	LP_1	-1.6	2.6	18.7	33.8	15.8
					-1.0	LP_2	2.0	2.6	15.2	30.9	16.8
					-1.0	LP_A	0. 2	1.8	17.0	32.4	11.5
					-2.0	LP_1	-3.2	2.7	5.7	23.2	20.7
					-2.0	LP_2	-3.4	2.7	14.7	30.4	18.7
					-2.0	LP_A	-3.3	1.9	10.4	27.0	13.9

n $10^{10}m^{-3}$	Te eV	Ti eV	m_{eff} amu	λ_D mm	V_f V	LP_x	ϵ_{n_I} %	δ_{n_I} %	ϵ_n %	ϵ_{n16} %	δ_n %
31.6	0.140	0.089	15.9	5.0	-1.0	LP_1	1.8	2.6	11.8	12.5	19.2
					-1.0	LP_2	0.7	2.6	15.7	16.3	18.3
					-1.0	LP_A	1.2	1.8	13.8	14.4	13.2
					-2.0	LP_1	-1.3	2.4	17.1	17.8	18.8
					-2.0	LP_2	-2.0	2.4	19.1	19.7	18.1
					-2.0	LP_A	-1.7	1.7	18.1	18.7	13.0
3.16	0.210	0.120	12.6	19.2	-1.0	LP_1	-2.5	2.0	11.2	29.2	12.6
					-1.0	LP_2	-2.3	2.0	-1.0	19.6	14.4
					-1.0	LP_A	-2.4	1.4	5.5	24.7	9.5
					-2.0	LP_1	-12.8	2.2	-8.6	13.5	18.2
					-2.0	LP_2	-12.8	2.2	-1.6	19.1	16.9
					-2.0	LP_A	-12.8	1.6	-5.0	16.4	12.4
10.0	0.220	0.107	11.3	11.0	-1.0	LP_1	-0.6	2.2	1.9	30.5	15.0
					-1.0	LP_2	-0.8	2.2	3.0	31.3	14.8
					-1.0	LP_A	-0.7	1.6	2.5	30.9	10.5
					-2.0	LP_1	-5.8	2.7	-0.7	28.6	20.2
					-2.0	LP_2	-5.2	2.6	-5.3	25.4	21.3
					-2.0	LP_A	-5.5	1.9	-2.9	27.0	14.7
10.0	0.280	0.121	16.0	12.4	-1.0	LP_1	2.8	2.3	8.0	8.3	18.5
					-1.0	LP_2	0.8	2.4	23.4	23.6	15.4
					-1.0	LP_A	1.8	1.7	16.4	16.7	11.9
					-2.0	LP_1	-0.5	2.8	1.4	1.6	25.7
					-2.0	LP_2	1.5	2.8	-15.0	-14.7	30.9
					-2.0	LP_A	0.5	2.0	-6.2	-5.9	19.9

Table 23: Relative errors in the inferred density calculated from probe simulations results. $\epsilon_{I_{pic}}$ is the relative error when Eq. 1 is used to infer density. ϵ_n and ϵ_n, correspond to relative error in inferred density when Eq. 5 and 7 are used respectively. δ_{n_I} and δ_n represents the relative uncertainties in their respective inferred densities. Positive errors indicate that calculated density is overestimated while negative signs refer to an underestimation. In all cases, ram velocity is 7673 m/s.

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n	Te	T_i	m_{eff}	λ_D	v_d	
$10^{10}m^{-3}$	0.156 eV	0.116 eV	8.3	29.4 mm	7673 m/s	
LP_x	Swarm Bus Included	$\lvert\vec{B}\rvert$ μT	V_p V	I_p nA	ϵ_{I_p} %	δ_{I_p} %
LP1	No	0	0.196	-45.267	1.2	0.1
LP1	No	0	0.496	-86.456	1.4	0.1
LP1	No	0	-0.168	-6.044	4.3	0.3
LP1	No	0	-0.138	-7.498	4.5	0.3
LP1	No	0	-0.109	-9.214	4.9	0.2
LP1	No	37.6	0.197	-40.871	-9.4	0.1
LP1	No	37.6	0.497	-71.750	-18.9	0.1
LP1	No	37.6	-0.236	-3.615	4.2	0.4
LP1	No	37.6	-0.207	-4.508	4.2	0.3
LP1	No	37.6	-0.178	-5.597	4.5	0.3
LP1	Yes	0	0.186	-36.179	-20.4	0.4
LP2	Yes	0	0.186	-35.535	-22.6	0.4
LPA	Yes	0	0.186	-35.857	-21.5	0.4
LP1	Yes	0	0.485	-72.408	-14.5	0.3
LP2	Yes	0	0.485	-73.237	-13.2	0.3
LPA	Yes	0	0.485	-72.822	-13.9	0.3
LP1	Yes	0	-0.136	-6.872	-10.4	0.8
LP2	Yes	0	-0.136	-6.965	-9.0	0.8
LPA	Yes	0	-0.136	-6.918	-9.7	0.8
LP1	Yes	0	-0.107	-8.577	-8.2	0.7
LP2	Yes	0	-0.107	-8.498	-9.2	0.7
LPA	Yes	0	-0.107	-8.537	-8.7	0.7
LP1	Yes	0	-0.078	-10.332	-9.4	0.6
LP2	Yes	0	-0.078	-10.379	-8.9	0.6
LPA	Yes	0	-0.078	-10.355	-9.2	0.6

Satellite floating potential $V_f = -1$ V.

n	Te	T_i	m_{eff}	λ_D	v_d	
$10^{10} m^{-3}$	0.156 eV	0.116 eV	8.3	29.4 mm	7673 m/s	
LP_x	Swarm Bus Included	$\lvert\vec{B}\rvert$ μT	V_p V	I_p nA	ϵ_{I_p} %	δ_{I_p} %
LP1	Yes	0	0.186	-24.033	-81.2	1.8
LP2	Yes	0	0.186	-23.920	-82.1	1.8
LPA	Yes	0	0.186	-23.976	-81.6	1.8
LP1	Yes	0	0.485	-51.631	-60.6	1.3
LP2	Yes	0	0.485	-50.668	-63.7	1.3
LPA	Yes	0	0.485	-51.149	-62.1	1.3
LP1	Yes	0	-0.136	-6.018	-26.1	1.8
LP2	Yes	0	-0.136	-6.017	-26.1	1.6
LPA	Yes	0	-0.136	-6.018	-26.1	1.7
LP1	Yes	0	-0.107	-7.173	-29.3	1.6
LP2	Yes	0	-0.107	-7.287	-30.1	1.5
LPA	Yes	0	-0.107	-7.151	-29.7	1.6
LP1	Yes	0	-0.078	-8.404	-34.5	1.5
LP2	Yes	0	-0.078	-8.339	-35.6	1.5
LPA	Yes	0	-0.078	-8.372	-35.0	1.5

Satellite floating potential $V_f = -2$ V.

n	Te	T_i	m_{eff}	λ_D	v_d	
$10^{10} m^{-3}$	0.156 eV	0.116 eV	8.3	29.4 mm	7673 m/s	
LP_x	Swarm Bus Included	$\lvert\vec{B}\rvert$ μT	V_p V	I_p nA	ϵ_{I_p} %	δ_{I_p} %
LP1	Yes	0	0.186	-7.398	-488.7	4.3
LP2	Yes	0	0.186	-7.287	-497.6	4.4
LPA	Yes	0	0.186	-7.342	-493.1	4.3
LP1	Yes	0	0.485	-15.289	-442.4	2.8
LP2	Yes	0	0.485	-14.887	-457.1	2.9
LPA	Yes	0	0.485	-15.088	-449.7	2.8
LP1	Yes	0	-0.136	-2.535	-199.3	3.6
LP2	Yes	0	-0.136	-2.462	-208.3	3.9
LPA	Yes	0	-0.136	-2.498	-203.7	3.7
LP1	Yes	0	-0.107	-2.866	-223.6	3.4
LP2	Yes	0	-0.107	-2.784	-233.2	3.8
LPA	Yes	0	-0.107	-2.825	-228.3	3.6
LP1	Yes	0	-0.078	-3.242	-248.8	3.4
LP2	Yes	0	-0.078	-3.125	-261.7	3.8
LPA	Yes	0	-0.078	-3.183	-255.1	3.6

n	Te	T_i	m_{eff}	λ_D	v_d	
$10^{10}m^{-3}$	0.156 eV	0.116 eV	8.3	29.4 mm	7673 m/s	
LP_x	Swarm Bus Included	$\lvert\vec{B}\rvert$ μT	V_p V	I_p nA	ϵ_{I_p} %	δ_{I_p} %
LP1	Yes	-37.6	0.235	-43.127	-1.3	1.0
LP2	Yes	-37.6	0.235	-40.534	-7.8	1.1
LPA	Yes	-37.6	0.235	-41.830	-4.4	1.0
LP1	Yes	-37.6	0.534	-76.634	-8.4	0.9
LP2	Yes	-37.6	0.534	-73.951	-12.3	0.9
LPA	Yes	-37.6	0.534	-75.293	-10.3	0.9
LP1	Yes	-37.6	-0.171	-5.644	26.0	1.9
LP2	Yes	-37.6	-0.171	-4.888	14.6	2.0
LPA	Yes	-37.6	-0.171	-5.266	20.7	1.9
LP1	Yes	-37.6	-0.142	-7.029	26.5	1.6
LP2	Yes	-37.6	-0.142	-6.031	14.3	1.8
LPA	Yes	-37.6	-0.142	-6.530	20.8	1.7
LP1	Yes	-37.6	-0.113	-8.597	26.0	1.5
LP2	Yes	-37.6	-0.113	-7.366	13.6	1.6
LPA	Yes	-37.6	-0.113	-7.982	20.3	1.6
LP1	Yes	+37.6	0.236	-40.708	-7.3	0.8
LP2	Yes	+37.6	0.236	-40.890	-6.8	0.8
LPA	Yes	+37.6	0.236	-40.799	-7.1	0.8
LP1	Yes	+37.6	0.535	-74.345	-11.7	0.6
LP2	Yes	+37.6	0.535	-75.426	-10.1	0.6
LPA	Yes	+37.6	0.535	-74.886	-10.9	0.6
LP1	Yes	+37.6	-0.154	-5.242	10.3	1.7
LP2	Yes	+37.6	-0.154	-5.912	20.5	1.6
LPA	Yes	+37.6	-0.154	-5.575	15.7	1.7
LP1	Yes	+37.6	-0.125	-6.518	11.0	1.5
LP2	Yes	+37.6	-0.125	-7.574	23.4	1.4
LPA	Yes	+37.6	-0.125	-7.046	17.7	1.4
LP1	Yes	+37.6	-0.096	-8.078	11.8	1.4
LP2	Yes	+37.6	-0.096	-9.342	23.7	1.3
LPA	Yes	+37.6	-0.096	-8.710	18.2	1.3

Satellite floating potential $V_f = -2$ V.

n	Te	T_i	m_{eff}	λ_D	v_d	
$10^{10}m^{-3}$	0.156 eV	0.116 eV	8.3	29.4 mm	7673 m/s	
LP_x	Swarm Bus Included	$\|\vec{B}\|$ μT	V_p V	I_p nA	ϵ_{I_p} %	δ_{I_p} %
LP1	Yes	+37.6	-0.136	-2.379	-219.0	4.4
LP2	Yes	+37.6	-0.136	-2.734	-177.5	3.6
LPA	Yes	+37.6	-0.136	-2.556	-196.8	4.0
LP1	Yes	+37.6	-0.107	-2.713	-241.9	4.3
LP2	Yes	+37.6	-0.107	-3.090	-200.1	3.5
LPA	Yes	+37.6	-0.107	-2.902	-219.6	3.9
LP1	Yes	+37.6	-0.078	-2.982	-279.1	4.3
LP2	Yes	+37.6	-0.078	-3.422	-230.4	3.5
LPA	Yes	+37.6	-0.078	-3.202	-253.1	3.9

Table 24: Electron linear and retardation currents calculated from simulations for configuration cases considered. ϵ_{I_p} is the relative error in the calculated current from simulations compared to predicted with OML theory Eq. 2, while δ_{I_p} is the relative uncertainty. Positive errors indicate overestimation while negative signs refer to an underestimation.

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n	Te	T_i	m_{eff}	λ_D	v_d	
$10^{11}m^{-3}$	0.280 eV	0.121 eV	16.0	12.4 mm	7673 m/s	
LP_x	Swarm Bus Included	$\|\vec{B}\|$ μT	V_p V	I_p nA	ϵ_{I_p} %	δ_{I_p} %
LP1	No	0	-0.290	-86.9	2.9	0.3
LP1	No	0	0.010	-274.3	12.2	0.2
LP1	No	0	-0.469	-41.7	1.2	0.4
LP1	No	0	-0.440	-47.1	1.5	0.3
LP1	No	0	-0.411	-53.2	1.7	0.3
LP1	No	37.6	-0.285	-88.4	2.7	0.3
LP1	No	37.6	0.015	-274.4	3.8	0.1
LP1	No	37.6	-0.467	-42.1	1.4	0.3
LP1	No	37.6	-0.438	-47.7	1.8	0.3
LP1	No	37.6	-0.409	-53.7	1.9	0.3
LP1	Yes	0	-0.291	-73.9	-10.7	1.1
LP2	Yes	0	-0.291	-75.1	-9.0	1.1
LPA	Yes	0	-0.291	-74.5	-9.8	1.1
LP1	Yes	0	0.008	-239.1	-4.8	0.6
LP2	Yes	0	0.008	-237.9	-5.3	0.6
LPA	Yes	0	0.008	-238.5	-5.1	0.6
LP1	Yes	0	-0.467	-35.1	-15.3	1.4
LP2	Yes	0	-0.467	-35.6	-13.7	1.4
LPA	Yes	0	-0.467	-35.3	-14.5	1.4
LP1	Yes	0	-0.438	-40.2	-13.6	1.3
LP2	Yes	0	-0.438	-40.2	-13.6	1.4
LPA	Yes	0	-0.438	-40.2	-13.6	1.3
LP1	Yes	0	-0.410	-44.6	-14.8	1.3
LP2	Yes	0	-0.410	-4.0	-11.2	1.3
LPA	Yes	0	-0.410	-45.3	-13.0	1.3

n	Te	T_i	m_{eff}	λ_D	v_d	
$10^{11}m^{-3}$	0.280 eV	0.121 eV	16.0	12.4 mm	7673 m/s	
LP_x	Swarm Bus Included	$\lvert\vec{B}\rvert$ μT	V_p V	I_p nA	ϵ_{I_p} %	δ_{I_p} %
LP1	Yes	-37.6	-0.213	-104.607	21.5	1.7
LP2	Yes	-37.6	-0.213	-96.506	14.9	1.7
LPA	Yes	-37.6	-0.213	-100.557	18.3	1.7
LP1	Yes	-37.6	0.086	-313.017	19.6	0.9
LP2	Yes	-37.6	0.086	-294.718	14.6	0.9
LPA	Yes	-37.6	0.086	-303.868	17.2	0.9
LP1	Yes	-37.6	-0.395	-48.783	18.5	1.9
LP2	Yes	-37.6	-0.395	-44.561	10.7	1.9
LPA	Yes	-37.6	-0.395	-46.672	14.8	1.9
LP1	Yes	-37.6	-0.365	-55.635	19.3	1.8
LP2	Yes	-37.6	-0.365	-50.284	10.7	1.9
LPA	Yes	-37.6	-0.365	-52.960	15.3	1.8
LP1	Yes	-37.6	-0.336	-63.136	20.0	1.6
LP2	Yes	-37.6	-0.336	-57.028	11.4	1.7
LPA	Yes	-37.6	-0.336	-60.082	15.9	1.7
LP1	Yes	+37.6	-0.210	-94.592	12.8	1.4
LP2	Yes	+37.6	-0.210	-101.242	18.5	1.4
LPA	Yes	+37.6	-0.210	-97.917	15.8	1.4
LP1	Yes	+37.6	0.088	-292.430	14.0	0.9
LP2	Yes	+37.6	0.088	-304.611	17.4	0.8
LPA	Yes	+37.6	0.088	-298.520	15.7	0.8
LP1	Yes	+37.6	-0.388	-42.764	5.4	1.7
LP2	Yes	+37.6	-0.388	-46.757	13.5	1.6
LPA	Yes	+37.6	-0.388	-44.760	9.6	1.6
LP1	Yes	+37.6	-0.359	-48.622	6.2	1.6
LP2	Yes	+37.6	-0.359	-54.105	15.7	1.5
LPA	Yes	+37.6	-0.359	-51.363	11.2	1.5
LP1	Yes	+37.6	-0.330	-55.373	7.3	1.7
LP2	Yes	+37.6	-0.330	-60.972	15.8	1.6
LPA	Yes	+37.6	-0.330	-58.172	11.7	1.7

Table 25: Electron linear and retardation currents calculated from simulations for configuration cases considered. ϵ_{I_p} is the relative error in the calculated current from simulations compared to predicted with OML theory Eq. 2, while δ_{I_p} is the relative uncertainty. Positive errors indicate overestimation while negative signs refer to an underestimation.

INFERRED ELECTRON TEMPERATURE

n $10^{10}m^{-3}$	T_e eV	T_i eV	m_{eff} amu	λ_D mm	V_f mV	$\lvert\vec{B}\rvert$ μT	Swarm	LP_x	ϵ_{T_e} %	δ_{T_e} %
1.00	0.156	0.116	8.3	29.4	-504	0	No	LP1	-3.8	0.5
1.00	0.156	0.116	8.3	29.4	-503	37.6	No	LP1	-1.9	0.7
1.00	0.156	0.116	8.3	29.4	-514	0	Yes	LP1	-1.4	1.0
								LP2	-0.6	1.0
								LPA	-1.0	1.0
1.00	0.156	0.116	8.3	29.4	-466	-37.6	Yes	LP1	-4.1	1.8
								LP2	0.0	1.6
								LPA	-2.2	1.7
1.00	0.156	0.116	8.3	29.4	-465	+37.6	Yes	LP1	-7.2	1.7
								LP2	-12.4	1.9
								LPA	-10.0	1.8
10.0	0.280	0.121	16.0	12.4	-990	0	No	LP1	-2.7	1.0
10.0	0.280	0.121	16.0	12.4	-985	37.6	No	LP1	-2.3	1.0
10.0	0.280	0.121	16.0	12.4	-990	0	Yes	LP1	3.2	2.0
								LP2	-8.9	2.3
								LPA	-2.8	2.2
10.0	0.280	0.121	16.0	12.4	-913	-37.6	Yes	LP1	-10.8	2.0
								LP2	-7.1	1.9
								LPA	-9.0	2.0
10.0	0.280	0.121	16.0	12.4	-911	+37.6	Yes	LP1	-9.7	2.0
								LP2	-14.4	2.1
								LPA	-12.1	2.1

Table 26: Relative errors in the inferred electron temperature from probe currents calculated from simulations. Two cases of plasma parameters are considered, whereas, the inclusion and orientation of a background magnetic field, as well as the presence of the Swarm satellite have been varied in both cases. The relative errors in the inferred electron temperature calculated from Eq. 8, are labeled as ϵ_{T_e}, while δ_{T_e} is the relative uncertainty in the estimated temperature. Positive errors indicate overestimation while negative signs refer to an underestimation. In all cases the drifting plasma speed is equal to the satellite ram velocity, $v_\perp = 7673\ m/s$.