CMOS090 technology
SVT MOS transistor models
Release DK_MIKRON

SPICE Model Characteristics : L/W/T scalings -

Crosscheck NMOS/PMOS

June 2010

TR&D / STD / T2D /

Modeling / CM2A

General information on SVT MOS transistor models

Supply voltage (Vdd) is 1.2 V.

Validity domain is defined as follows:

Drawn gate length varies from 0.1 um to 1 um.

Drawn transistor width varies from 0.12 um to 1.0 um.

Device temperature varies from -40 ˚C to +150 ˚C.

Vgs, Vds and Vbs vary from 0 V to 1.32 V (i.e. Vdd + 10%).

Conditions of simulation

Simulations were done with Bench v3.6.3sram using Eldo simulator v6.7_1.2.

If not explicitly mentioned elsewhere, temperature is set to temp ° C and Vbs to 0 V.

Extra global parameters used:

- svt_dev = 0

Output parameters definition

In what follows, M, W and L (all default to 1) designate the number of devices in parallel (i.e. multiplication factor), the total drawn gate width and the drawn gate length, respectively.

- **Vt_lin:** Threshold voltage defined as Vgs value for which drain current is 40e-9 A/sq*M*W/L at Vds = 0.025 V.
- **Vt_sat:** Threshold voltage defined as Vgs value for which drain current is 40e-9 A/sq*M*W/L at Vds = 1.2 V.
- **Ilow:** Drain current at Vgs = 0.6 V, Vds = 1.2 V.
- **Ihigh:** Drain current at Vgs = 1.2 V, Vds = 0.6 V.
- **Ieff:** Average drain current (Ilow + Ihigh) / 2.
- **Ilin:** Drain current at Vgs = 1.2 V, Vds = 0.025 V.
- **Isat:** Drain current at Vgs = 1.2 V, Vds = 1.2 V.
- **Ioffsat:** Drain current at Vgs = 0 V, Vds = 1.2 V.
- **Slp_sat:** Sub-threshold slope at Vds = 1.2 V, extracted from drain current vs. Vgs curve between its minimum and 40e-9 A/sq*M*W/L.
- **Ig_on:** Gate current at Vds = 0 V and Vgs = 1.2 V.
- **Ioff_g:** Gate current at Vgs = 0 V, Vds = 1.2 V.
- **Ioff_s:** Source current at Vgs = 0 V, Vds = 1.2 V.

- **Ioff_b:** Bulk current at Vgs = 0 V, Vds = 1.2 V.
- **Cgg_inv:** Total gate capacitance at Vgs = 1.2 V, Vds = 0 V, f = 100k Hz.
- **Cggmean:** Average total gate capacitance for Vgs values between 0 V and 1.2 V, Vds = 0 V, f = 100k Hz.
- **Cgd_0V:** Gate-to-Drain capacitance at Vgs = 0 V, Vds = 0 V, f = 100k Hz.
- **Cbd_off:** Bulk-to-Drain capacitance at Vgs = 0 V, Vds = 0 V, f = 100k Hz.
- **Gm_c:** Drain transconductance at Vgs = Vt_lin + 0.2 V, Vds = 0.6 V, f = 100k Hz.
- **Gd_c:** Drain conductance at Vgs = Vt_lin + 0.2 V, Vds = 0.6 V, f = 100k Hz.
- **Gain_c:** Voltage gain defined as Gm_c / Gd_c.
- **VtGmmax:** Threshold voltage at Vds = 0.025 V derived from Gm max method.

NSVT

Electrical characteristics per geometry

nsvt W=1.0e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Vt_lin [mV]	424	375	321
Vt_sat [mV]	328	267	195
Ilin [uA]	45.201	52.604	61.302
Isat [uA]	452.26	535.47	634.71
Ioffsat [pA]	57.016	292.99	2037.2
Slp_sat [mV/dec]	84.86	84.6	84.91
Ig_on [pA]	2.1191	4.1644	8.1915
Ioff_g [pA]	-0.39348	-0.77408	-1.5261
Ioff_s [nA]	-0.056622	-0.29221	-2.0356
Ioff_b [fA]	-0.09244	-0.50852	-3.8601
Cgg_inv [fF]	1.4143	1.3676	1.3166
Cggmean [fF]	1.1959	1.1845	1.1688
Cgd_0V [aF]	384.68	394.02	406.02
Cbd_off [aF]	848.55	743.52	634.07
Gm_c [uS]	299.61	328.21	358.52

nsvt W=1.0e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Gain_c []	14.867	12.746	10.613
VtGmmax [mV]	541	500	457

nsvt W=0.12e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Vt_lin [mV]	354	298	234
Vt_sat [mV]	262	194	113
Ilin [uA]	5.1133	6.4345	8.0664
Isat [uA]	54.097	68.665	87.022
Ioffsat [pA]	21.973	170.8	1884.1
Slp_sat [mV/dec]	78.15	78.73	80.07
Ig_on [fA]	260.95	558.43	1195
Ioff_g [fA]	-40.178	-86.061	-183.23
Ioff_s [nA]	-0.021933	-0.17071	-1.884
Ioff_b [fA]	-0.031747	-0.21162	-1.7833
Cgg_inv [aF]	239.85	243.89	246.37
Cggmean [aF]	218.74	225.25	230.89
Cgd_0V [aF]	72.909	76.803	81.592
Cbd_off [aF]	136.49	125.4	111.35
Gm_c [uS]	37.722	43.588	49.975

nsvt W=0.12e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Gain_c []	15.11	12.976	10.812
VtGmmax [mV]	447	404	355

nsvt W=1.0e-6 L=1.0e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Vt_lin [mV]	271	232	193
Vt_sat [mV]	239	200	161
Ilin [uA]	6.3263	6.8711	7.4491
Isat [uA]	94.551	108.36	123.56
Ioffsat [pA]	30.84	92.934	289.76
Slp_sat [mV/dec]	76.24	75.33	74.71
Ig_on [pA]	29.159	59.538	121.46
Ioff_g [pA]	-0.39348	-0.77408	-1.5261
Ioff_s [pA]	-30.446	-92.157	-288.22
Ioff_b [fA]	-1.074	-3.4106	-12.532
Cgg_inv [fF]	12.03	12.358	12.7
Cggmean [fF]	9.4121	9.9409	10.504
Cgd_0V [aF]	461.31	507.47	598.89
Cbd_off [aF]	869.32	786.49	721.54
Gm_c [uS]	32.579	34.742	37

nsvt W=1.0e-6 L=1.0e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Gain_c []	61.079	61.136	61.194
VtGmmax [mV]	360	322	284

PSVT

Electrical characteristics per geometry

psvt W=1.0e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Vt_lin [mV]	439	387	328
Vt_sat [mV]	334	273	199
Ilin [uA]	10.578	12.15	14.011
Isat [uA]	183.45	220.75	267.6
Ioffsat [pA]	69.696	304.71	2036.6
Slp_sat [mV/dec]	87.88	86.6	85.87
Ig_on [fA]	450.04	957.11	2069.2
Ioff_g [fA]	-28.303	-51.77	-93.862
Ioff_s [nA]	-0.069668	-0.30465	-2.0365
Ioff_b [fA]	-0.21176	-0.97727	-6.849
Cgg_inv [fF]	1.3659	1.3192	1.2684
Cggmean [fF]	1.1619	1.1518	1.1387
Cgd_0V [aF]	385.6	395.73	408.43
Cbd_off [aF]	668.34	592.14	513.32
Gm_c [uS]	130.7	146.15	166.7

psvt W=1.0e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Gain_c []	12.613	11.266	9.7708
VtGmmax [mV]	457	413	362

psvt W=0.12e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Vt_lin [mV]	446	390	328
Vt_sat [mV]	340	275	198
Ilin [uA]	1.1712	1.4242	1.7262
Isat [uA]	19.892	25.619	33.015
Ioffsat [pA]	7.2681	33.83	239.74
Slp_sat [mV/dec]	87.77	86.46	85.39
Ig_on [fA]	56.26	127.78	293.51
Ioff_g [fA]	-3.5891	-7.0092	-13.498
Ioff_s [pA]	-7.2644	-33.823	-239.73
Ioff_b [fA]	-0.027391	-0.16014	-1.3321
Cgg_inv [aF]	234.07	237.69	239.8
Cggmean [aF]	211.1	217.31	222.83
Cgd_0V [aF]	72.848	76.546	80.662
Cbd_off [aF]	113.13	104.13	93.081
Gm_c [uS]	14.832	17.385	20.731

psvt W=0.12e-6 L=0.1e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Gain_c []	12.288	11.061	9.6464
VtGmmax [mV]	456	412	361

psvt W=1.0e-6 L=1.0e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

	SVT_SS	SVT_TT	SVT_FF
Vt_lin [mV]	277	244	212
Vt_sat [mV]	237	204	172
Ilin [uA]	1.4343	1.5364	1.6427
Isat [uA]	27.607	30.583	33.713
Ioffsat [pA]	26.885	69.628	182.23
Slp_sat [mV/dec]	74.3	73.6	73.13
Ig_on [pA]	3.2562	6.9168	14.699
Ioff_g [fA]	-108.01	-212.16	-417.69
Ioff_s [pA]	-26.776	-69.413	-181.8
Ioff_b [fA]	-0.89131	-2.5585	-9.4267
Cgg_inv [fF]	11.715	12.013	12.321
Cggmean [fF]	9.0957	9.5613	10.053
Cgd_0V [aF]	492.35	598.3	785.72
Cbd_off [aF]	689.6	641.79	606.71
Gm_c [uS]	15.456	16.502	17.692

psvt W=1.0e-6 L=1.0e-6 po2act=0.63e-6 tometer=1 lpe=0 @ temp=25

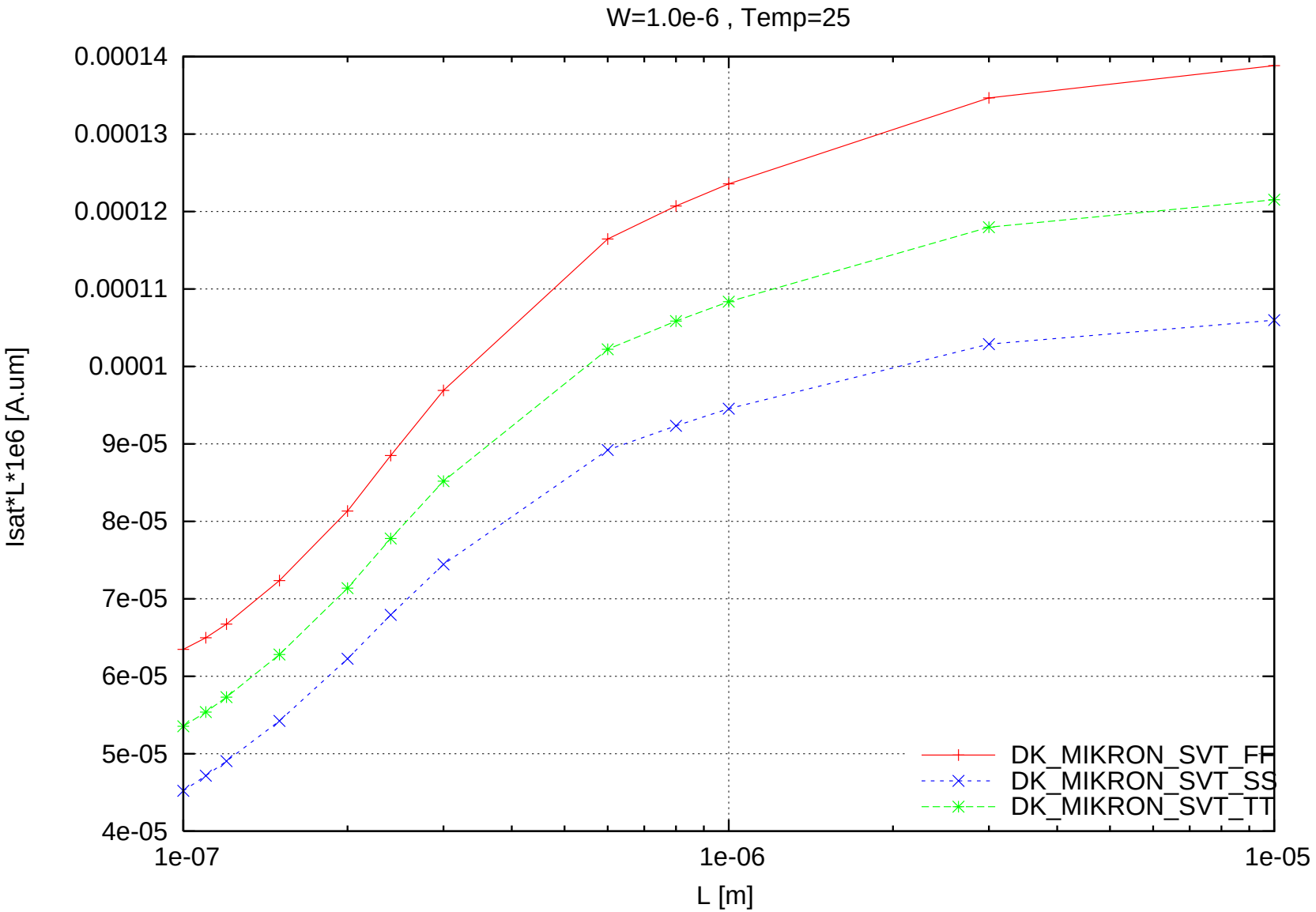
	SVT_SS	SVT_TT	SVT_FF
Gain_c []	44.848	44.741	44.606
VtGmmax [mV]	274	243	213

NSVT

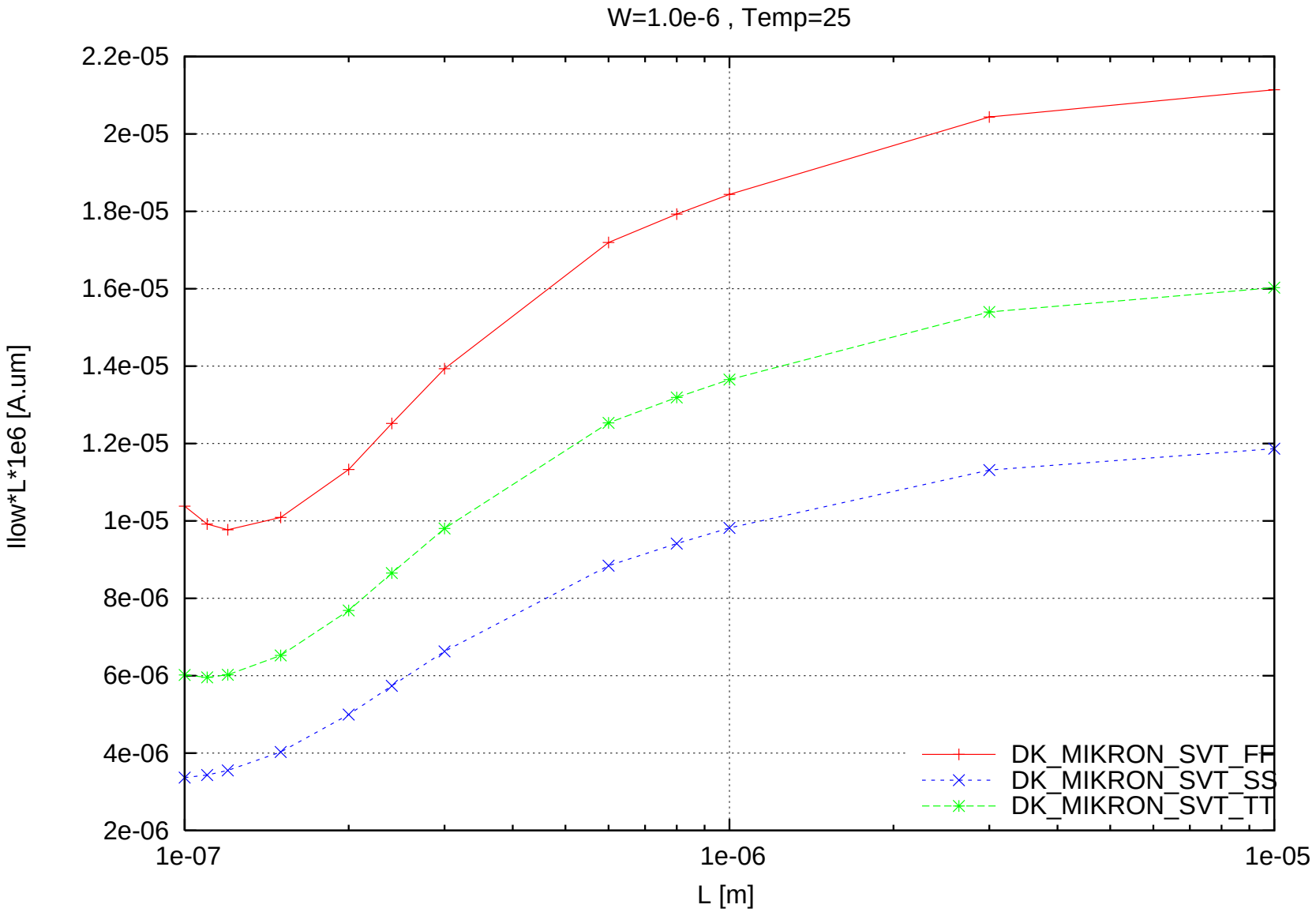
Electrical characteristics scaling

Scaling versus Length for NMOS (W=1.0e-6, Temp=25, po2act=0.63e-6, LPE=0)

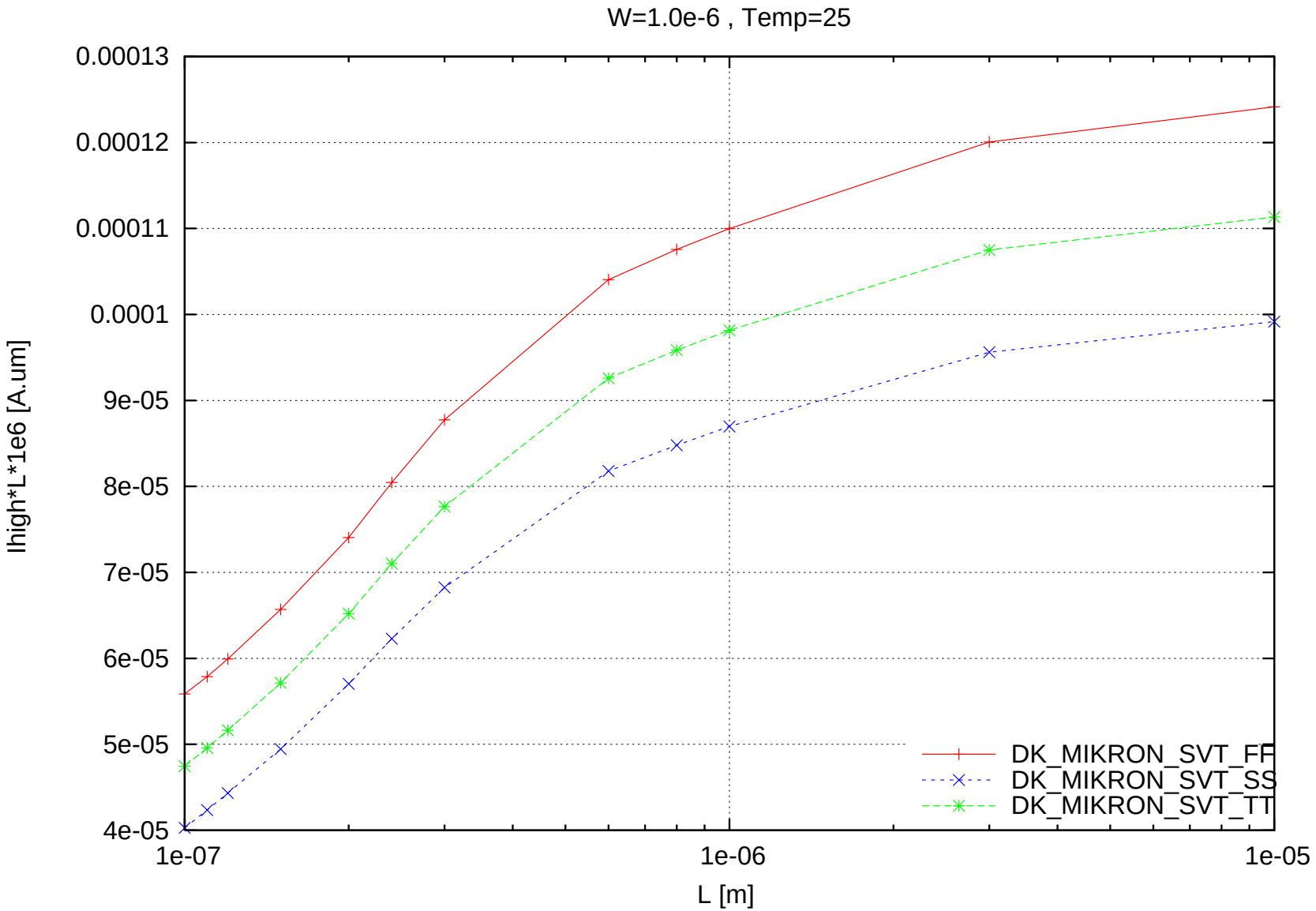
nsvt Isat*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



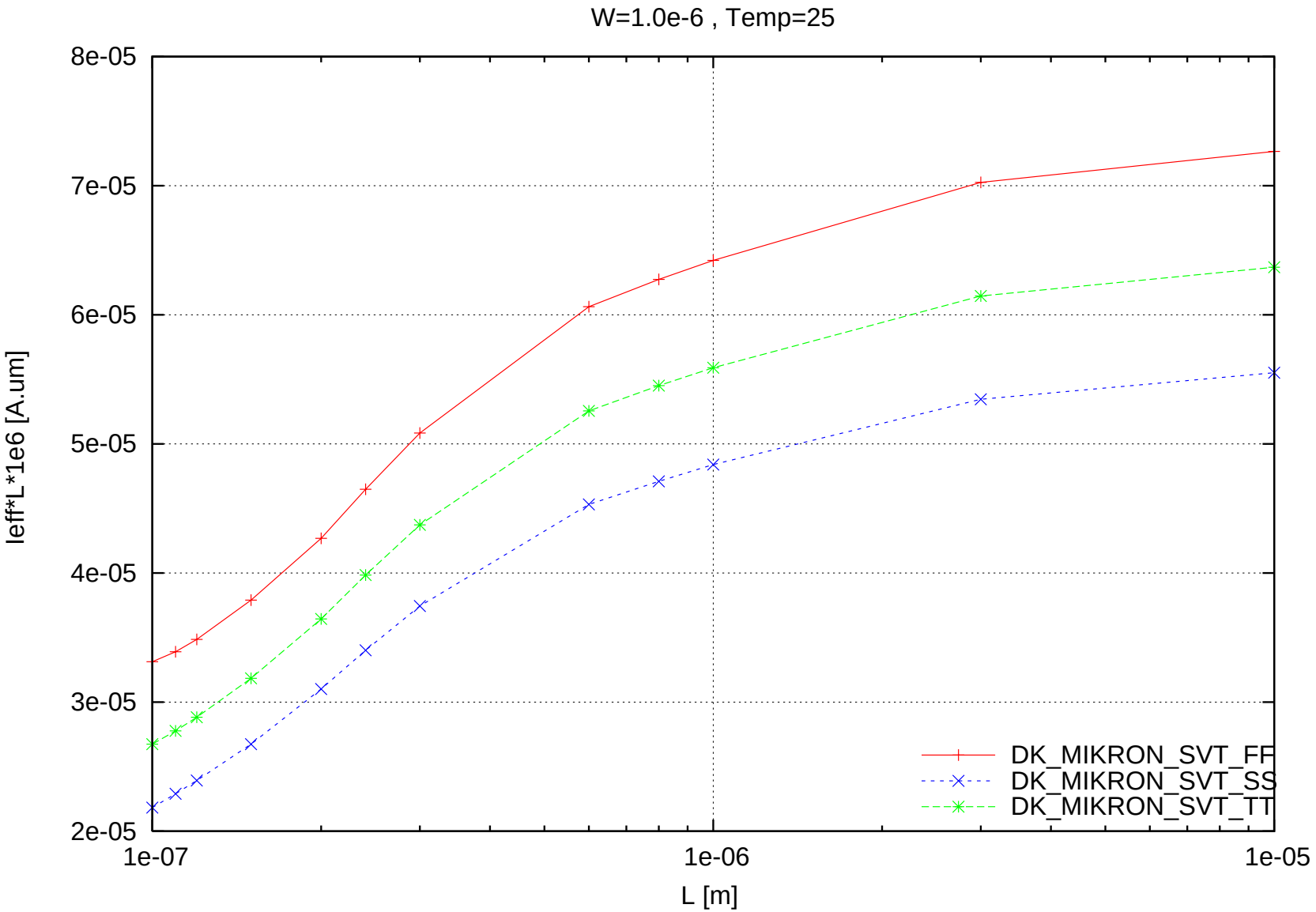
nsvt Ilow*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



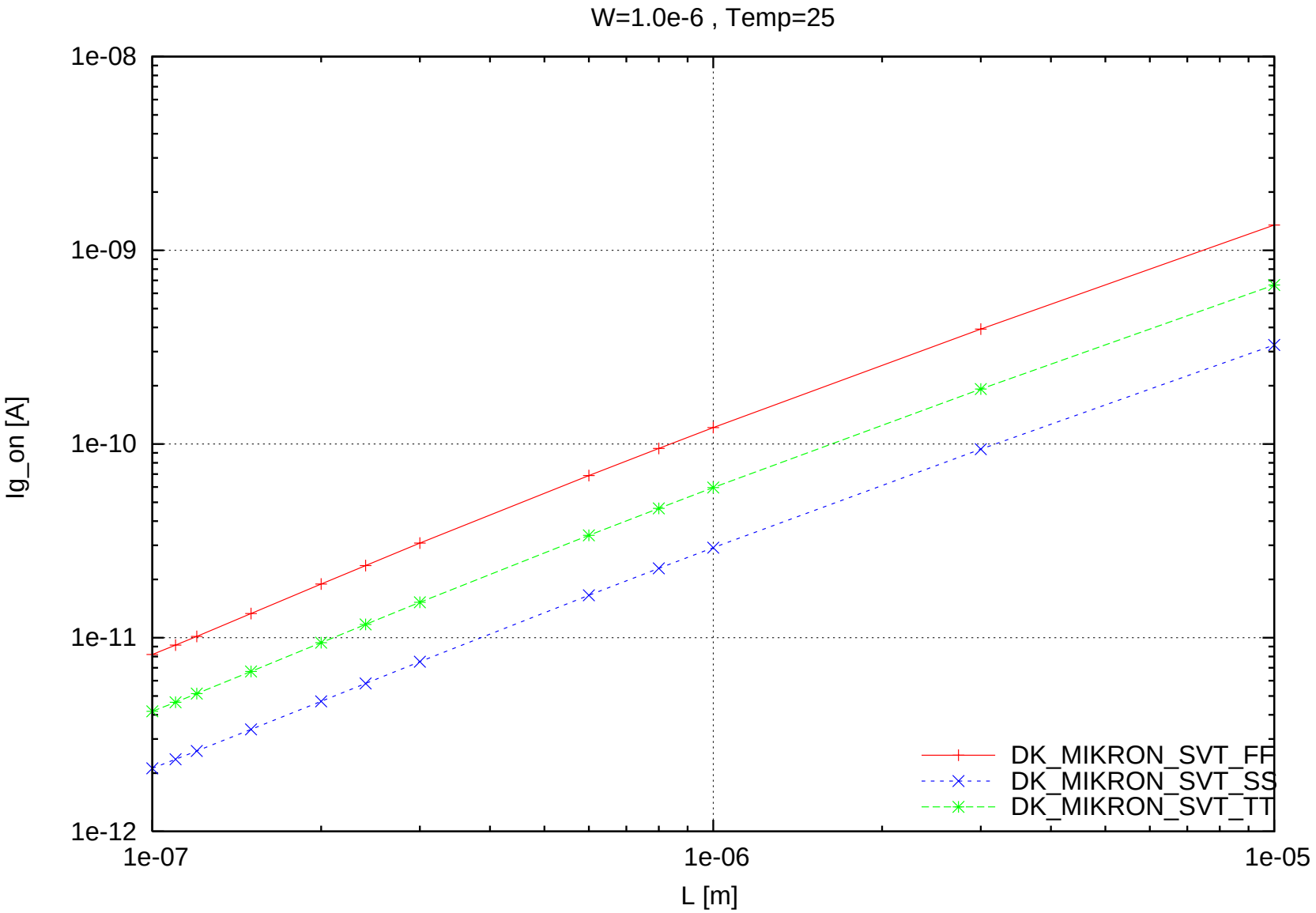
nsvt Ihigh*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



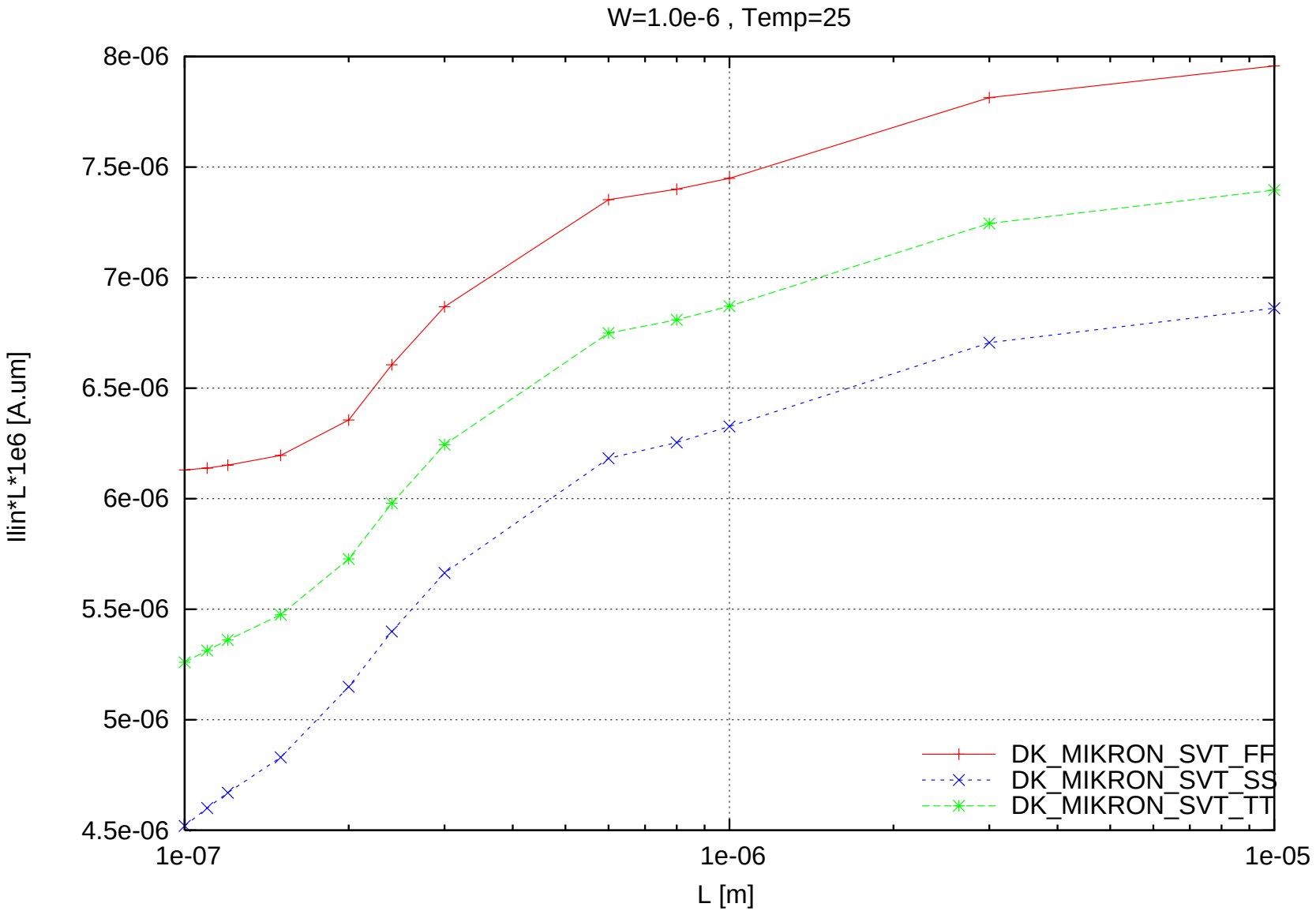
nsvt Ieff*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



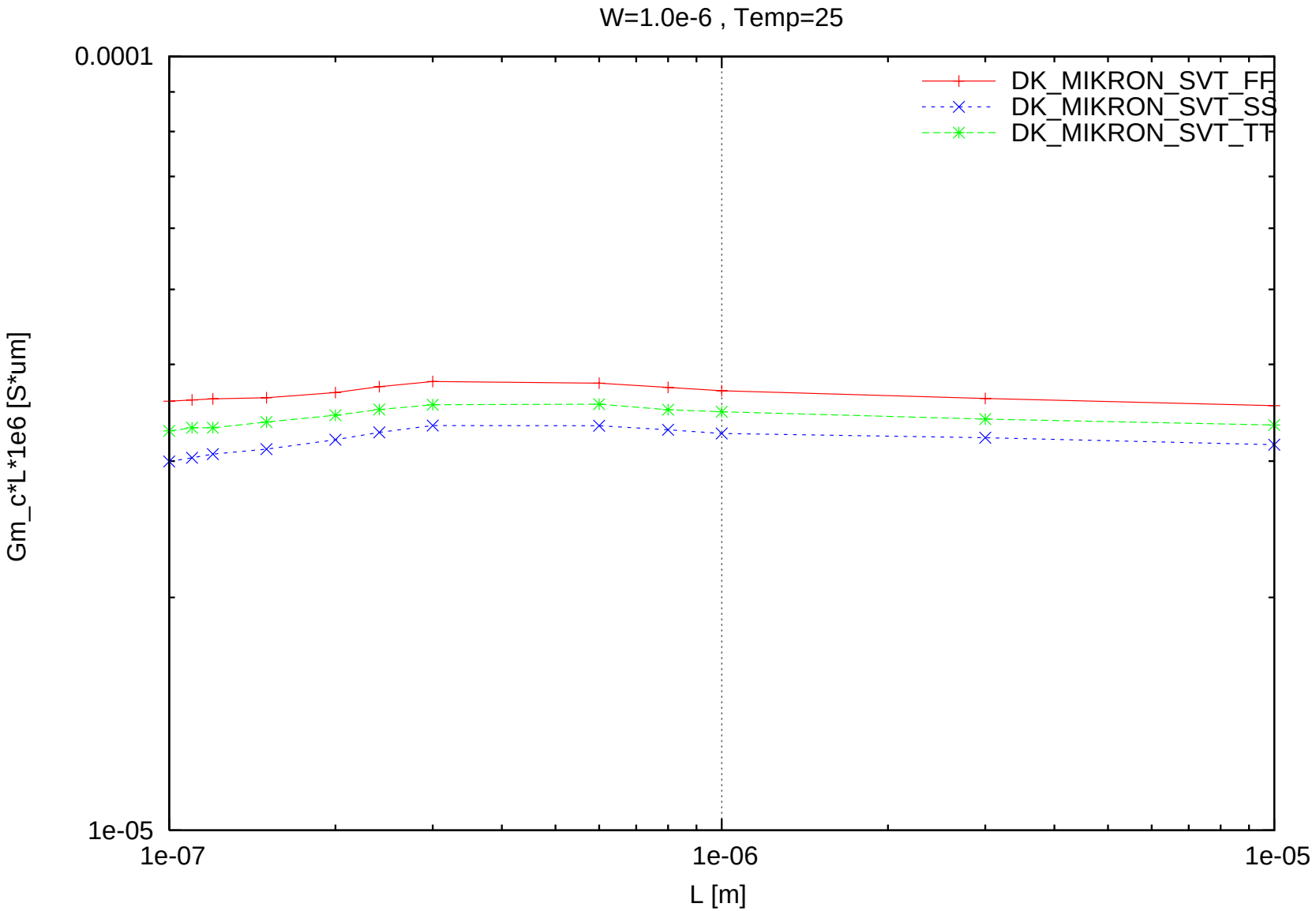
nsvt Ig_on [A] vs. L [m] , W=1.0e-6 , Temp=25



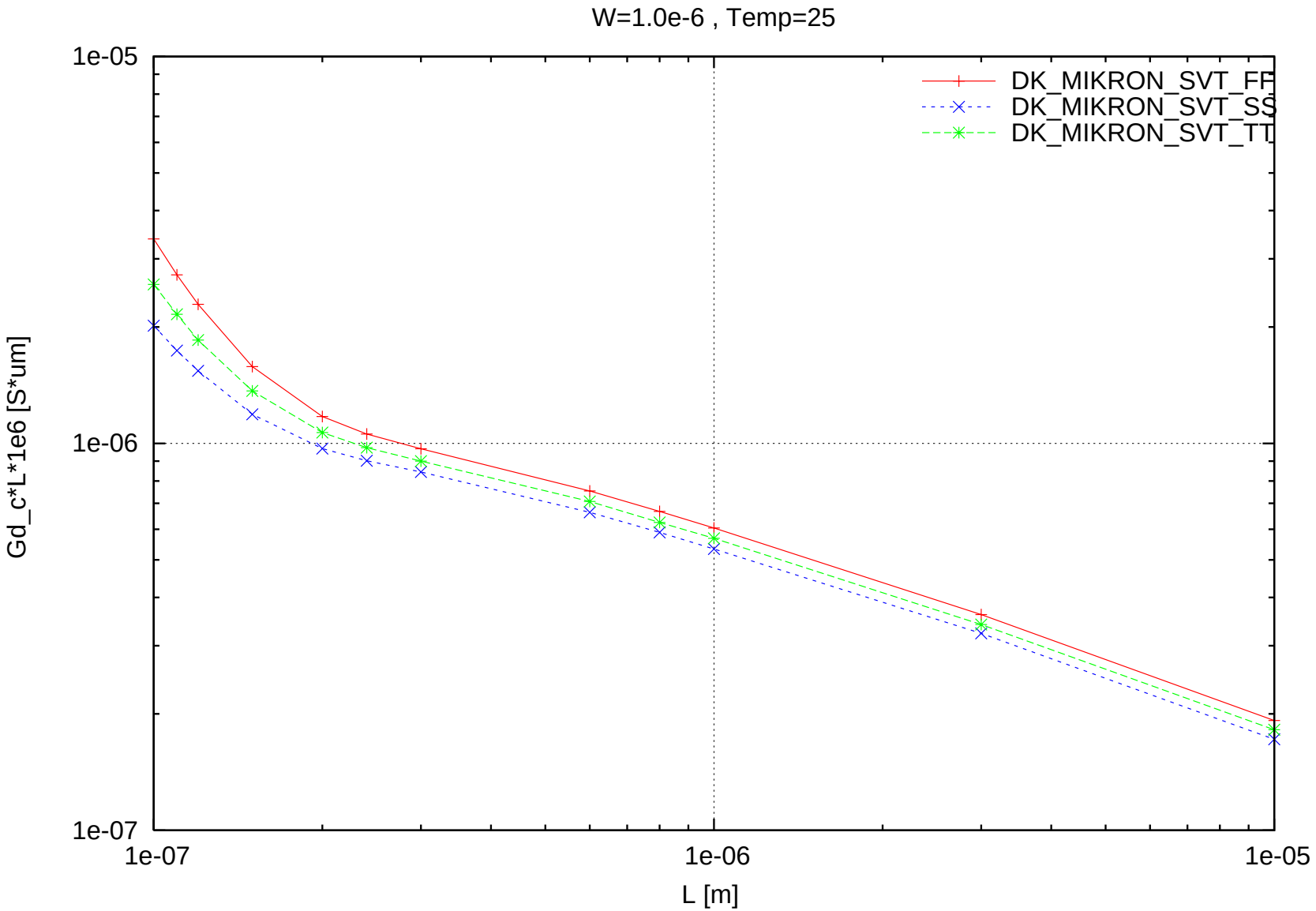
nsvt Ilin*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



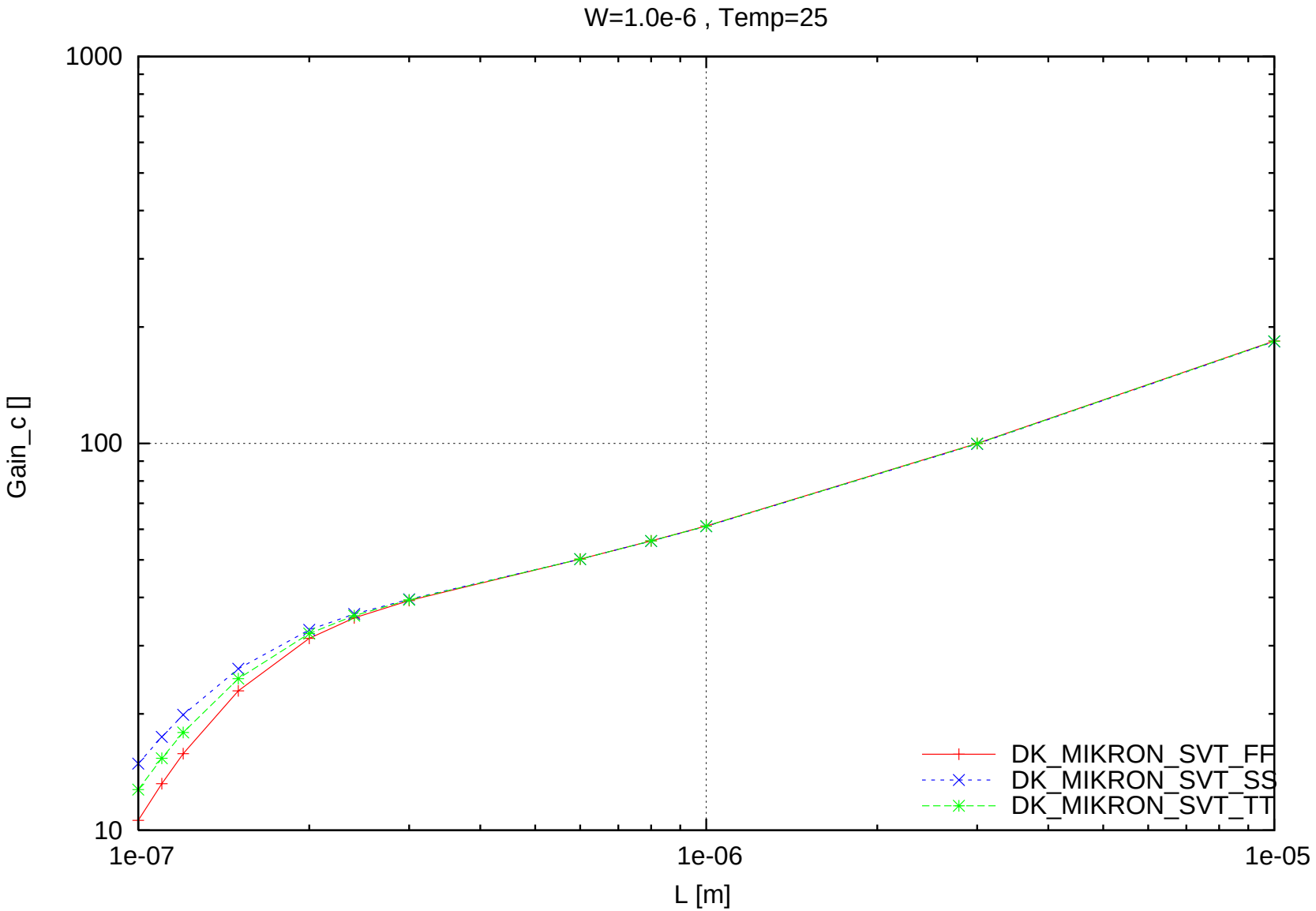
nsvt Gm_c*L*1e6 [S*um] vs. L [m] , W=1.0e-6 , Temp=25



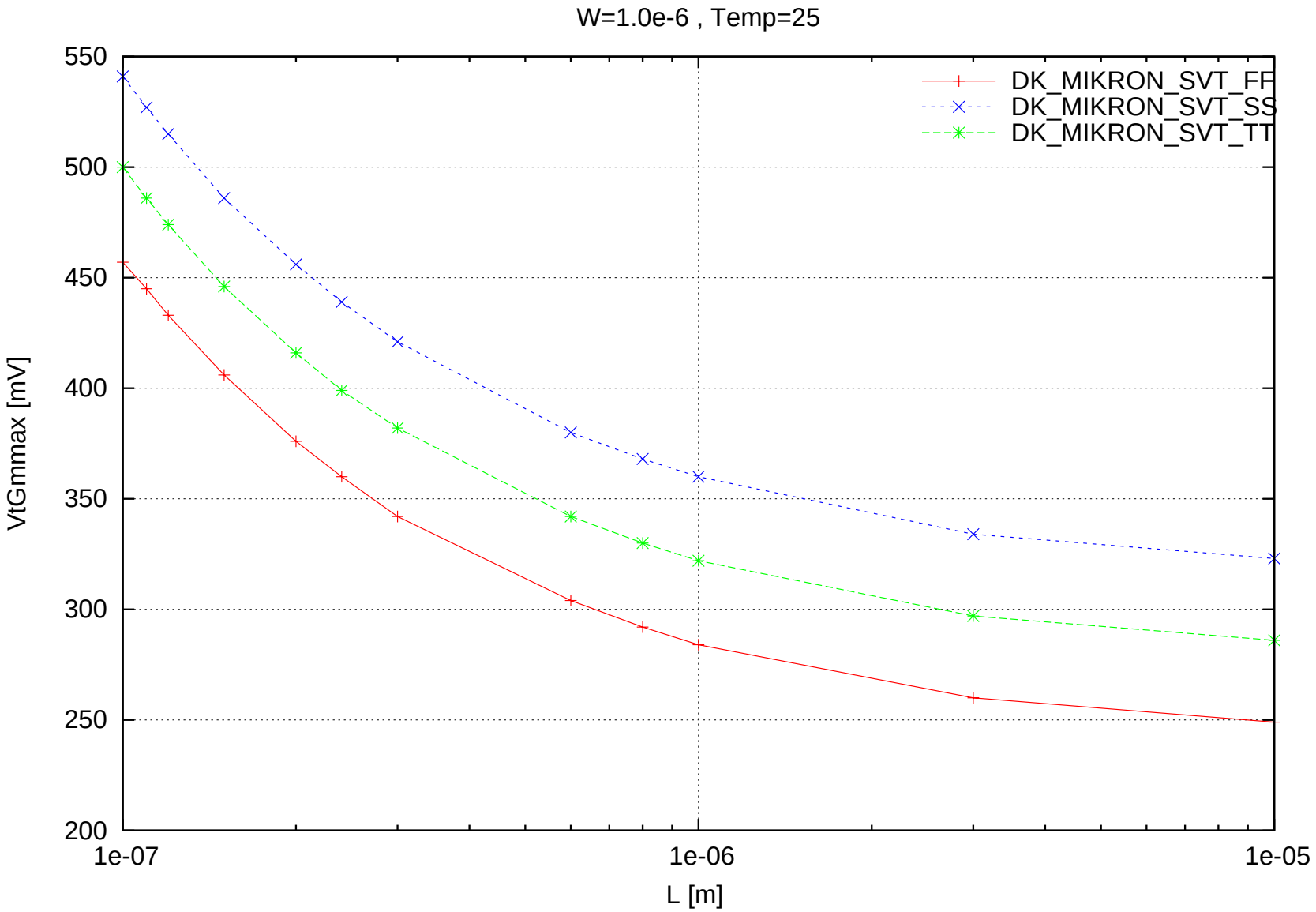
nsvt Gd_c*L*1e6 [S*um] vs. L [m] , W=1.0e-6 , Temp=25



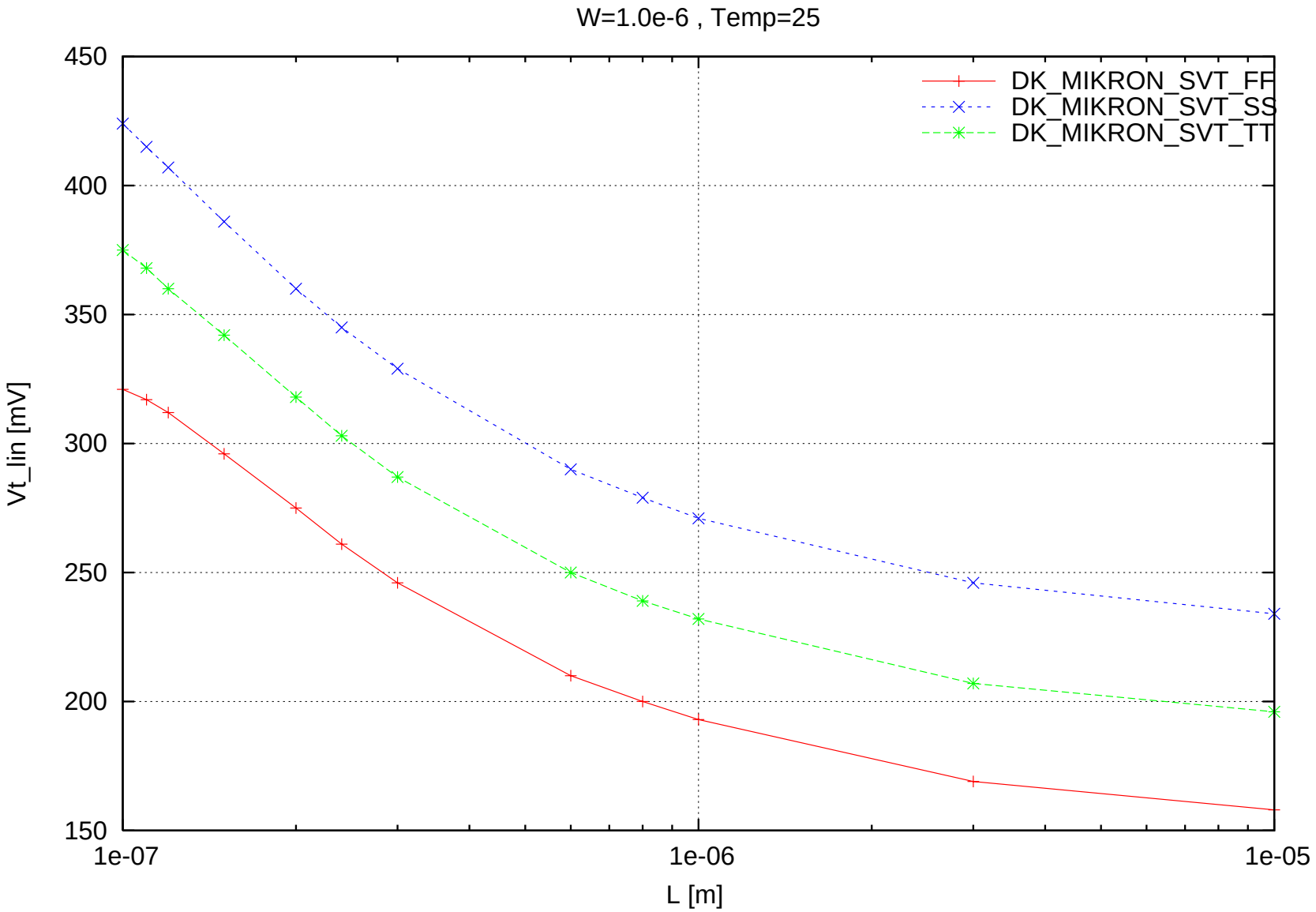
nsvt Gain_c [] vs. L [m] , W=1.0e-6 , Temp=25



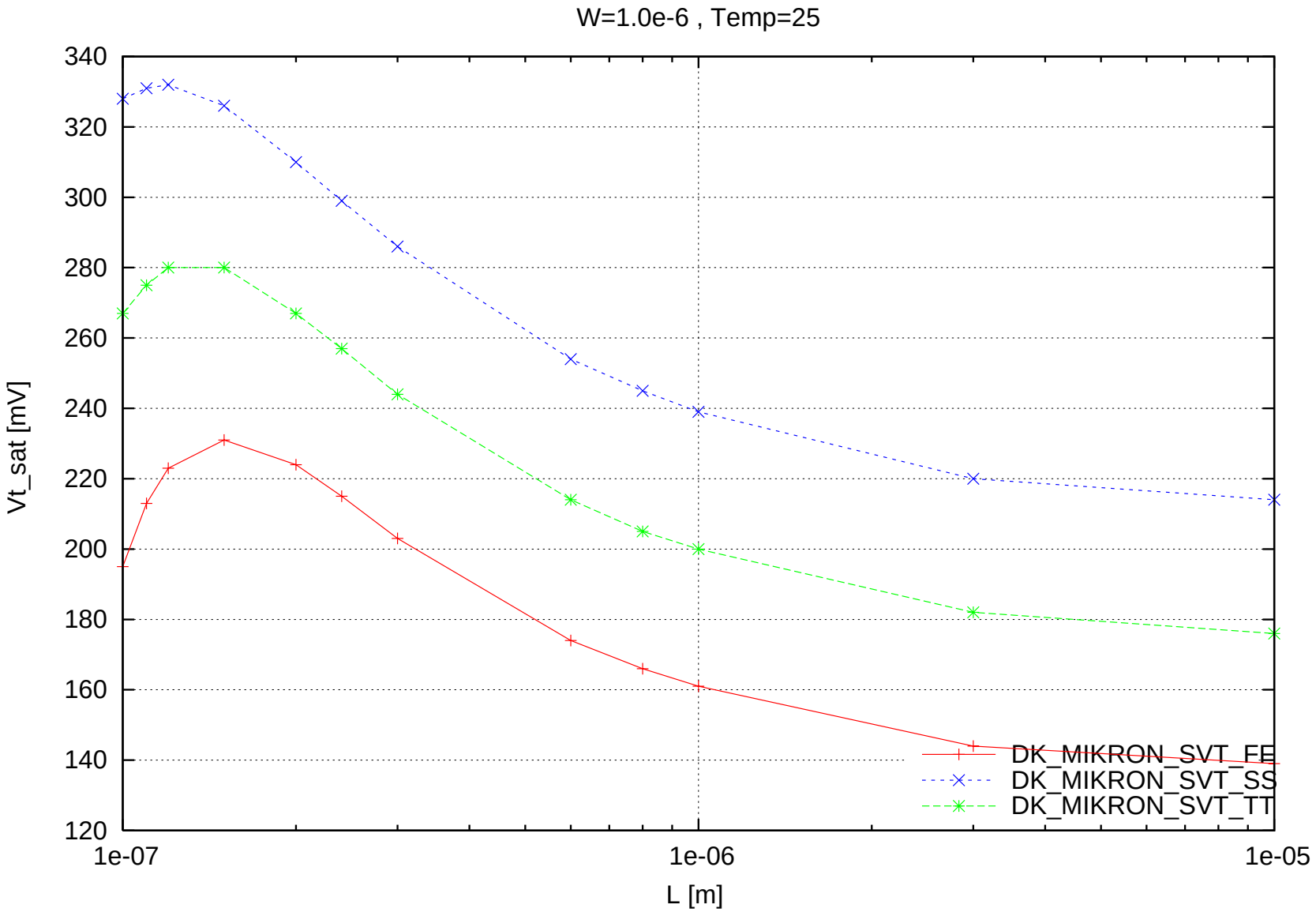
nsvt VtGmmax [mV] vs. L [m] , W=1.0e-6 , Temp=25



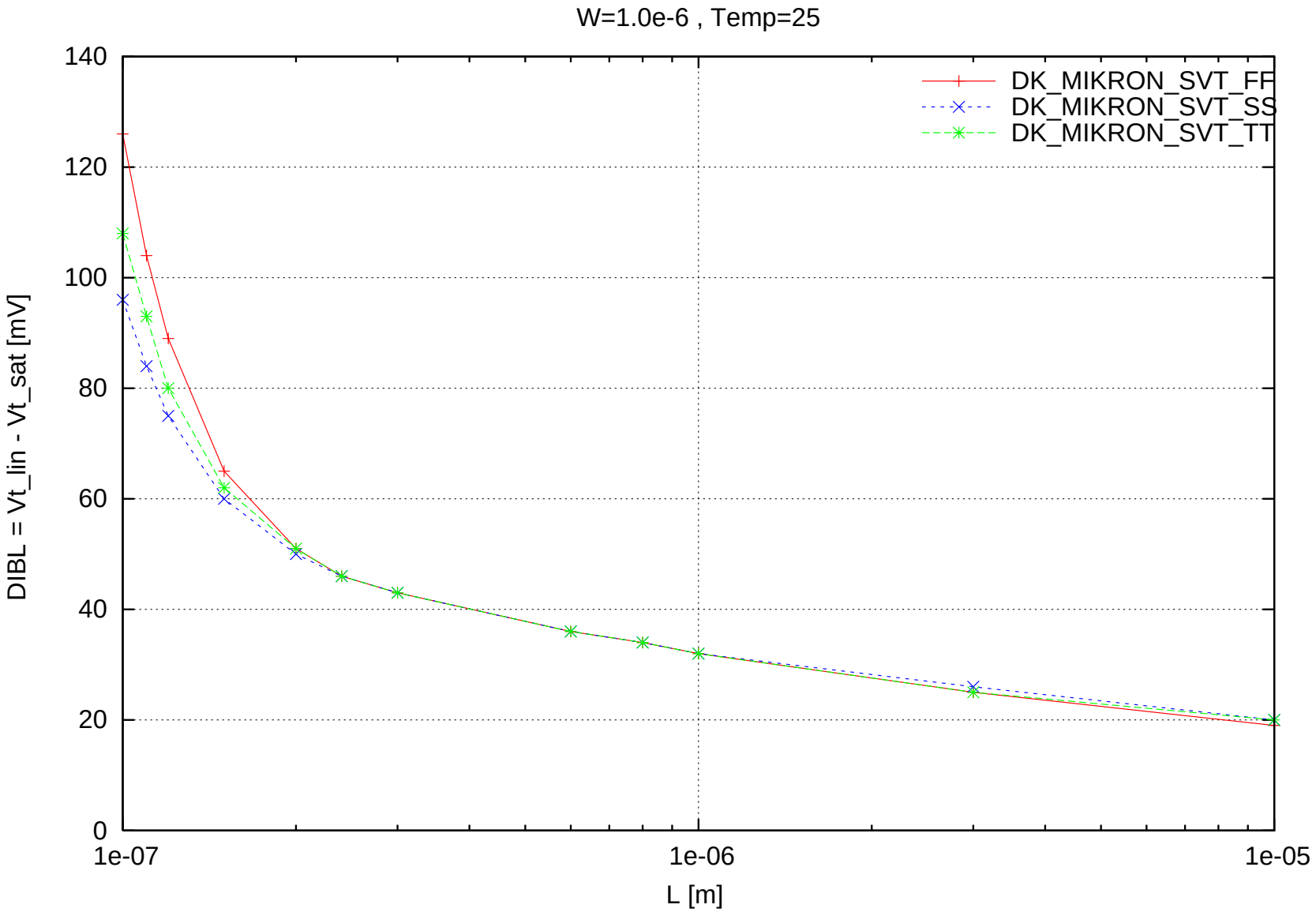
nsvt Vt_lin [mV] vs. L [m] , W=1.0e-6 , Temp=25



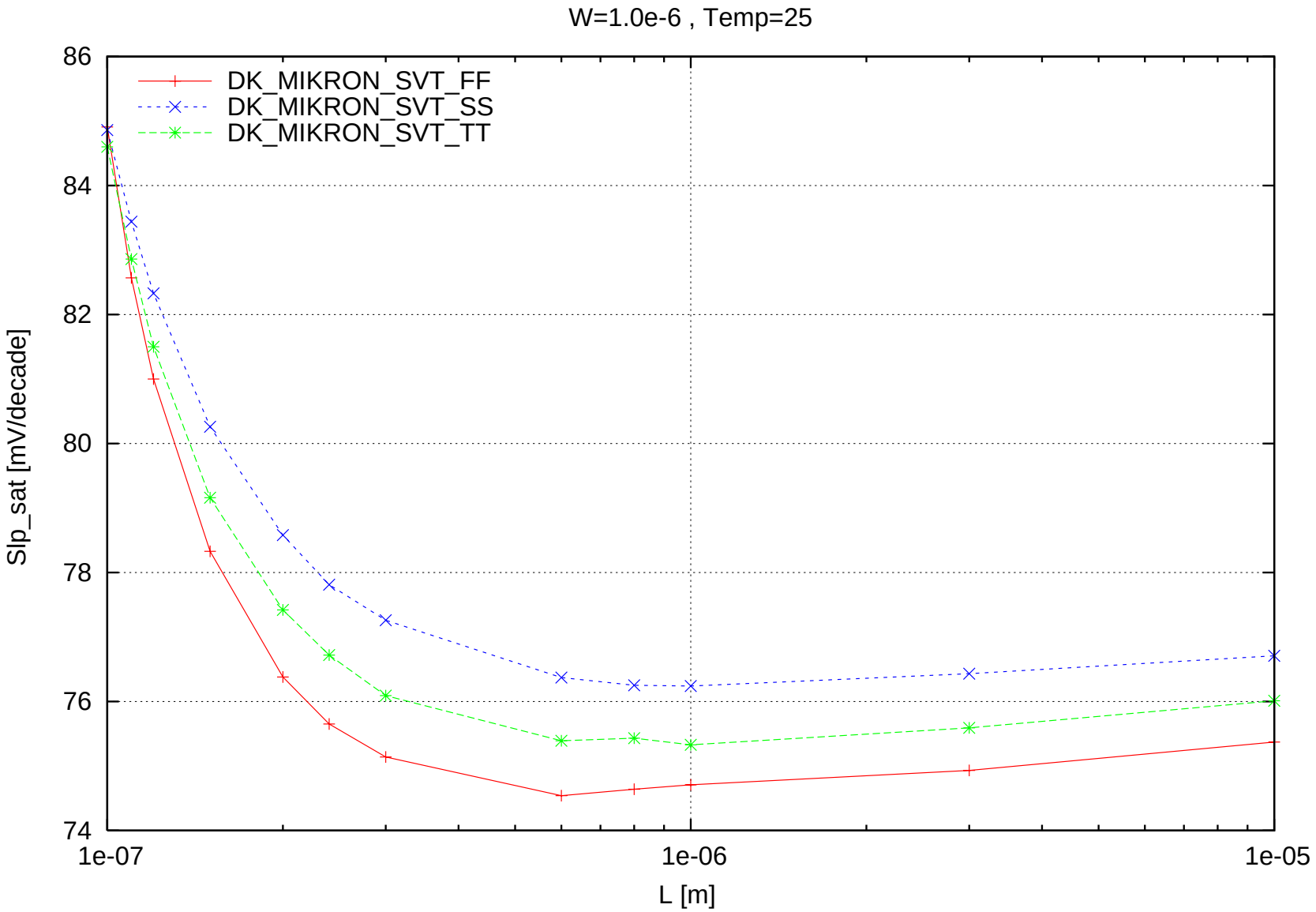
nsvt Vt_sat [mV] vs. L [m] , W=1.0e-6 , Temp=25



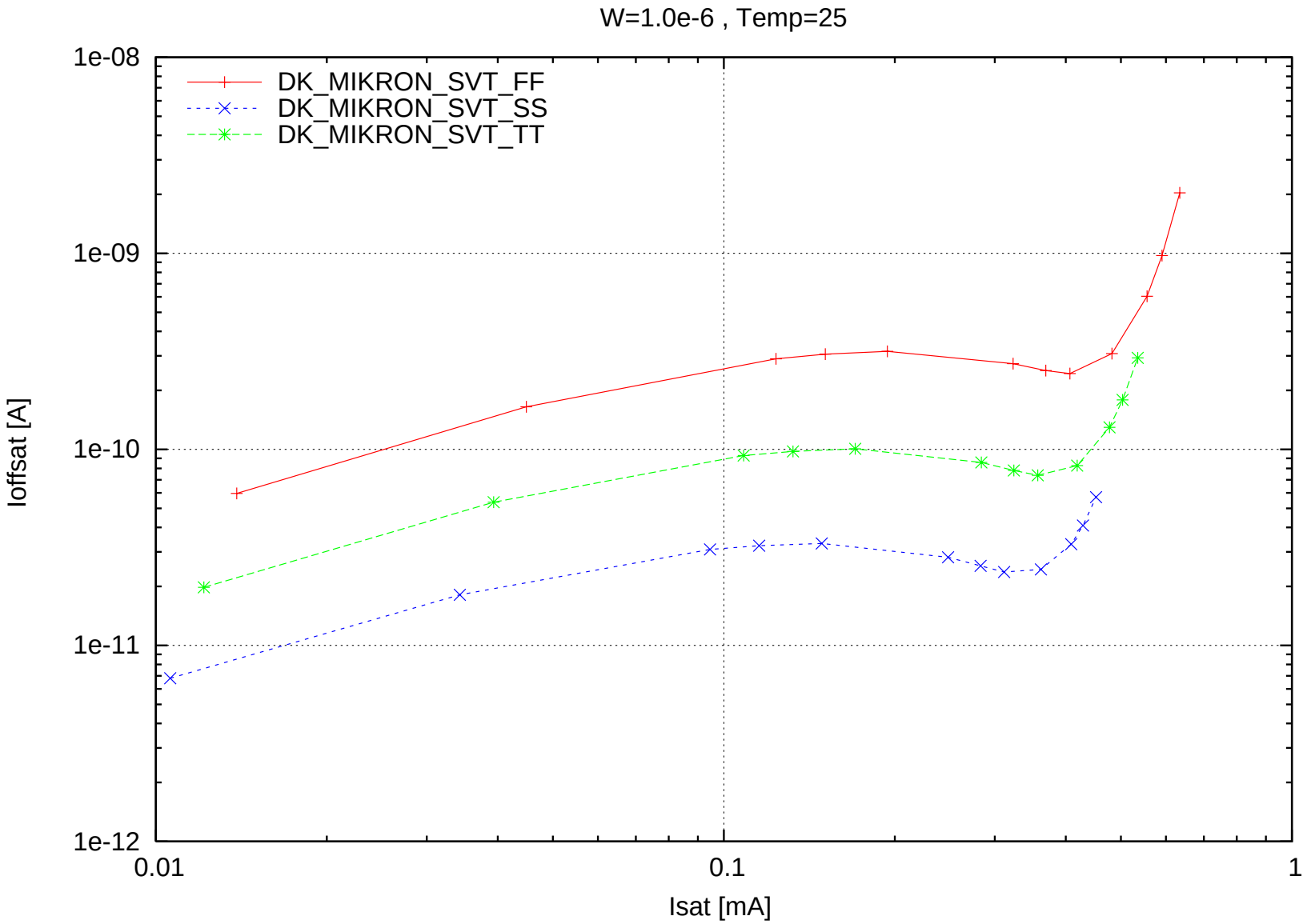
nsvt DIBL = Vt_lin - Vt_sat [mV] vs. L [m] , W=1.0e-6 , Temp=25



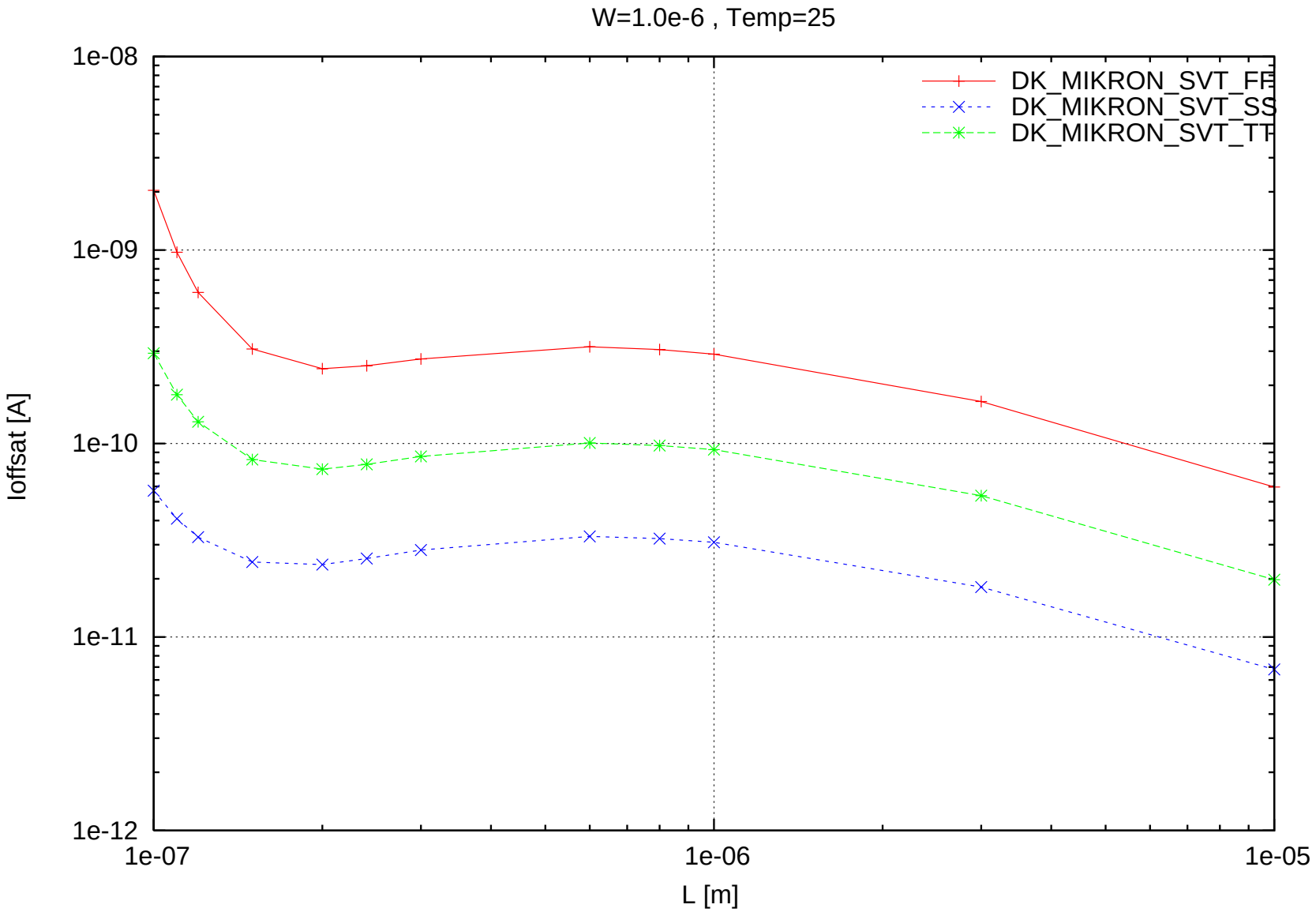
nsvt Slp_sat [mV/decade] vs. L [m] , W=1.0e-6 , Temp=25



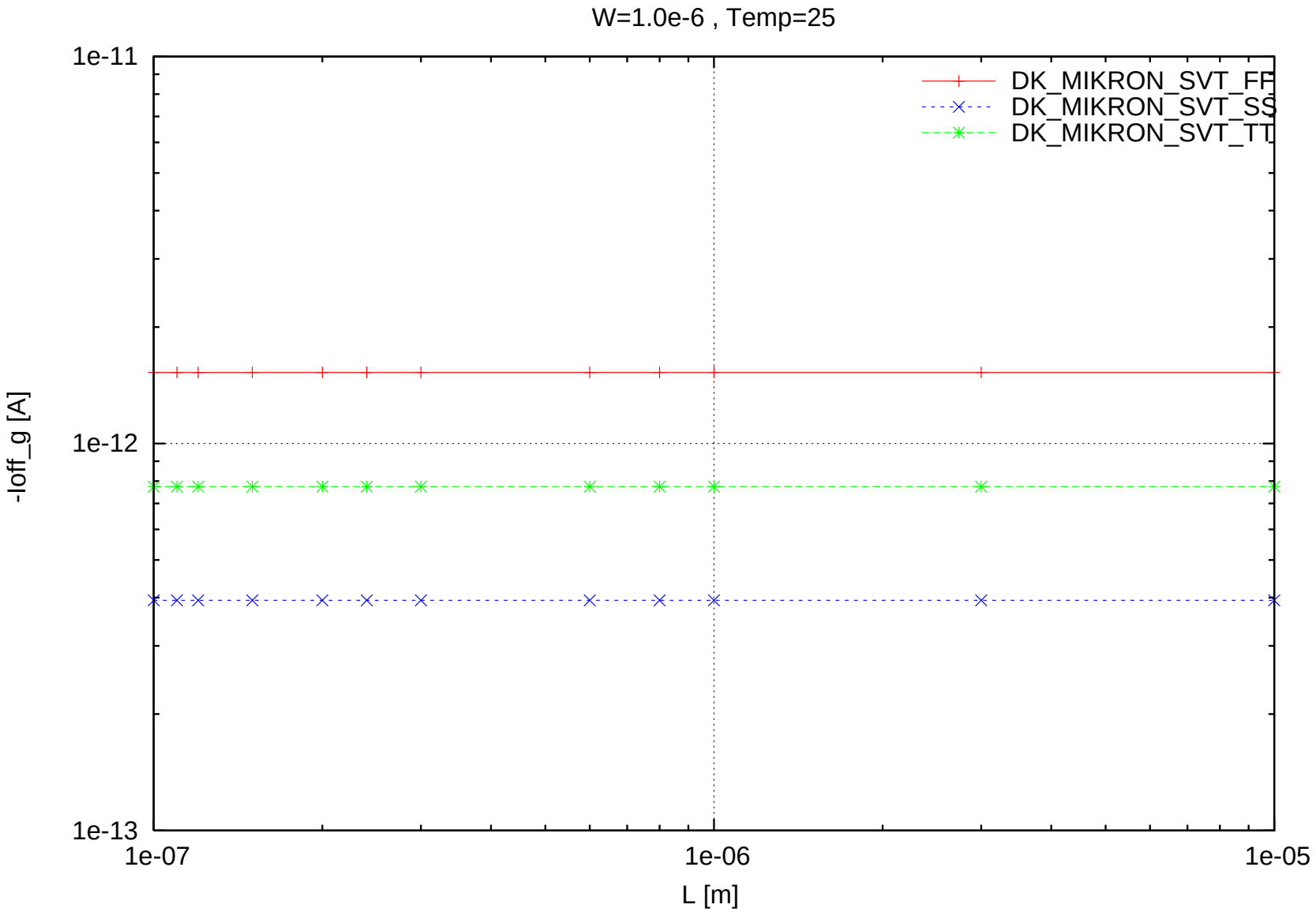
nsvt Ioffsat [A] vs. Isat [mA] , W=1.0e-6 , Temp=25



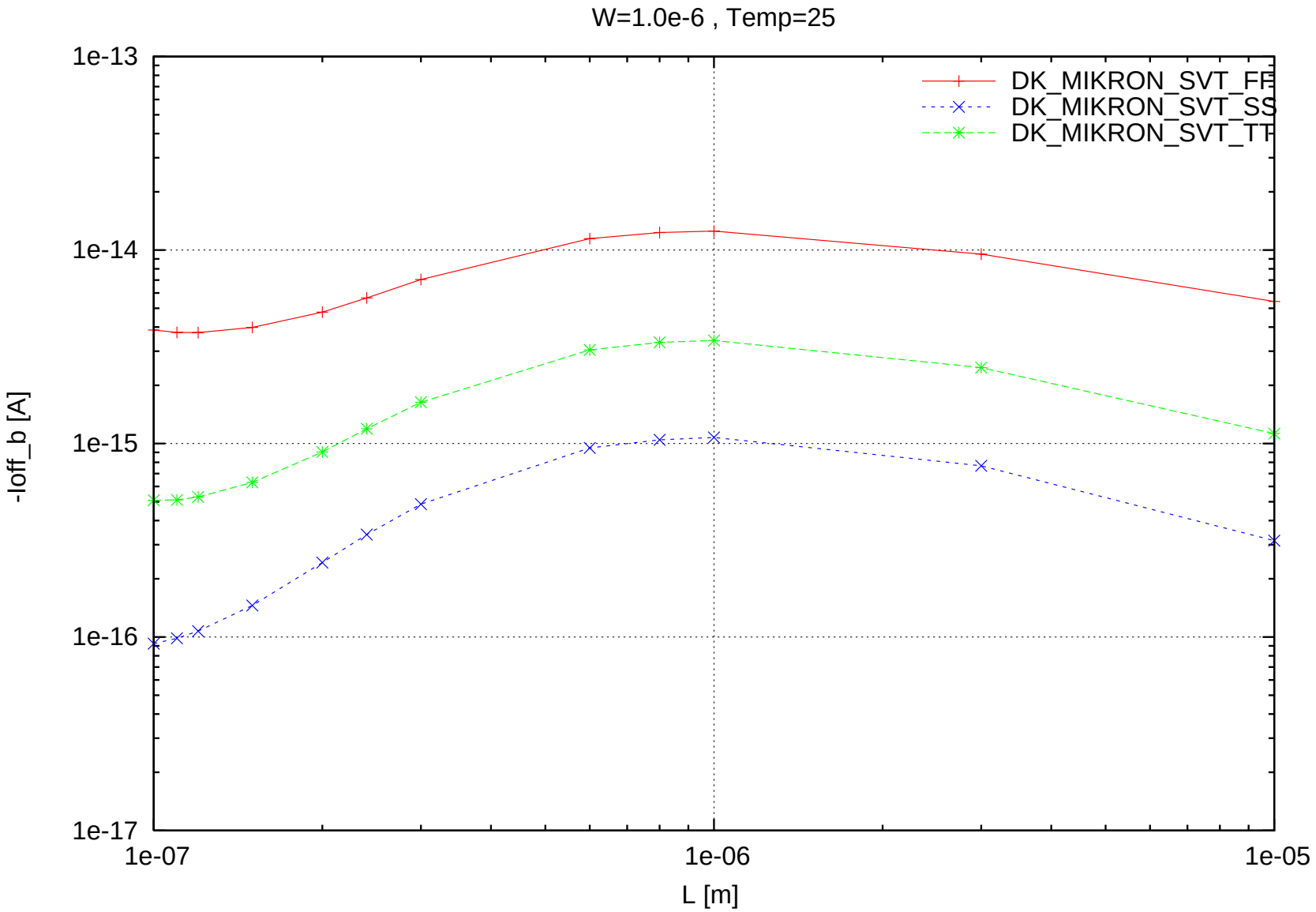
nsvt Ioffsat [A] vs. L [m] , W=1.0e-6 , Temp=25



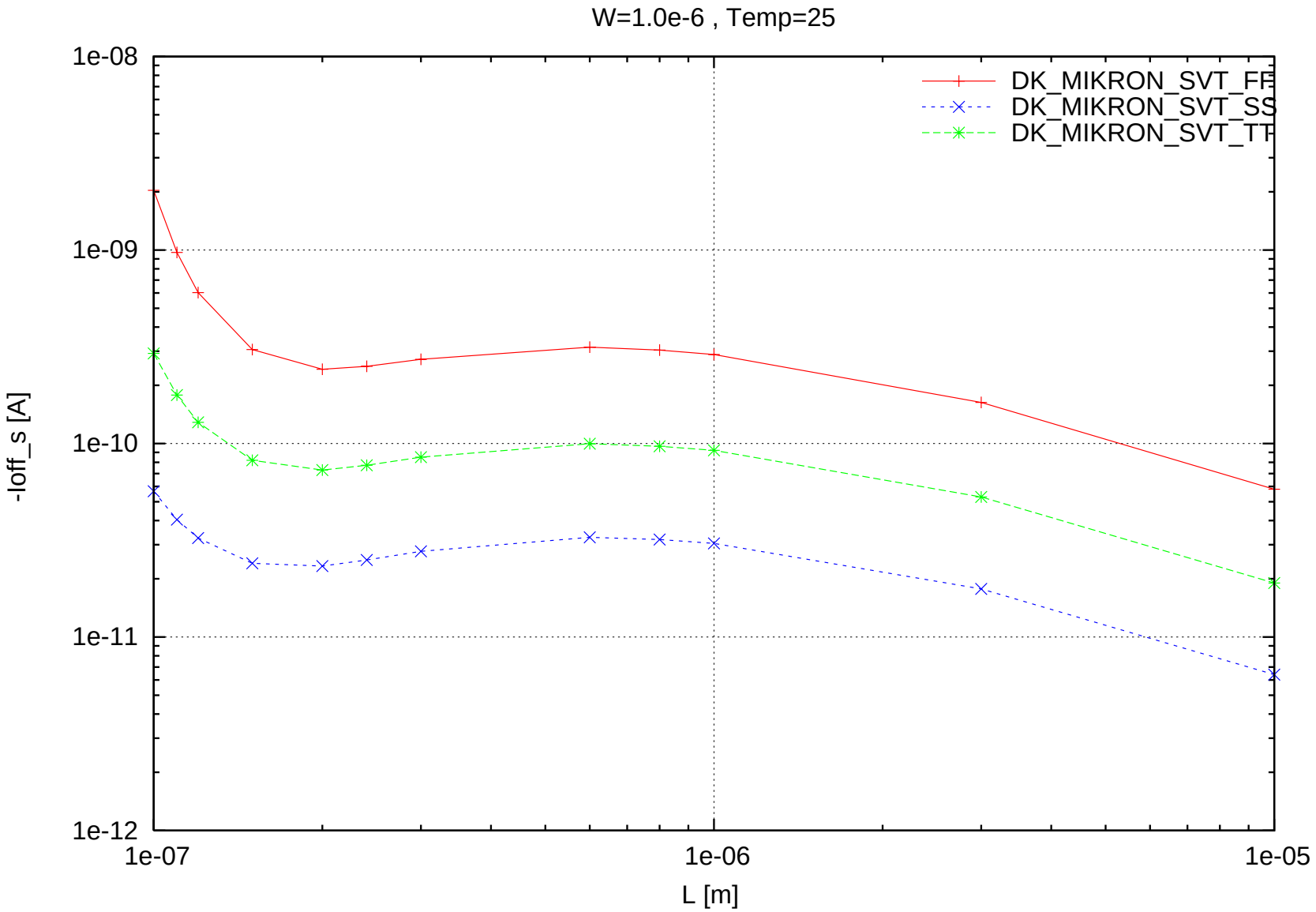
nsvt -Ioff_g [A] vs. L [m] , W=1.0e-6 , Temp=25



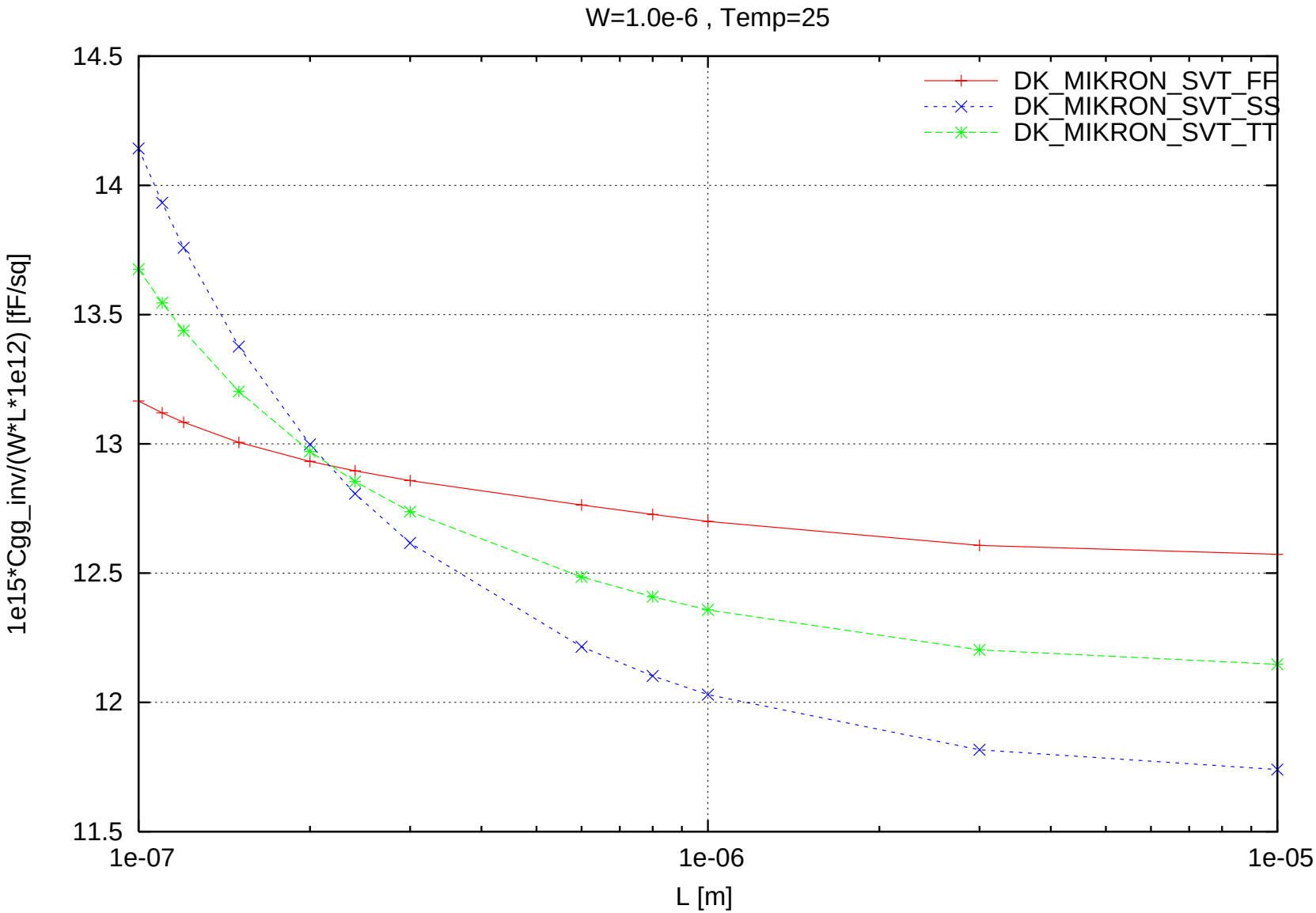
nsvt -Ioff_b [A] vs. L [m] , W=1.0e-6 , Temp=25



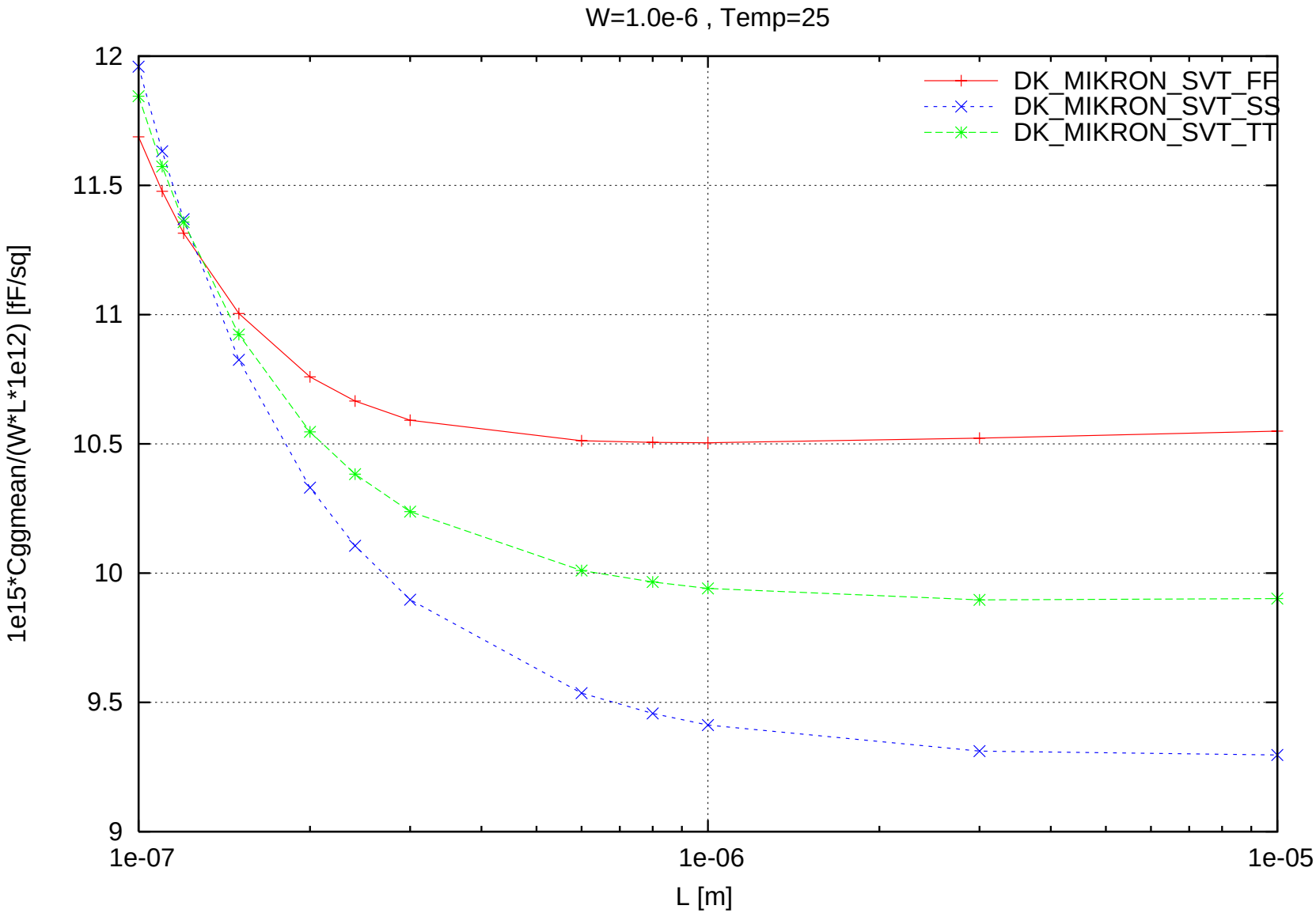
nsvt -Ioff_s [A] vs. L [m] , W=1.0e-6 , Temp=25



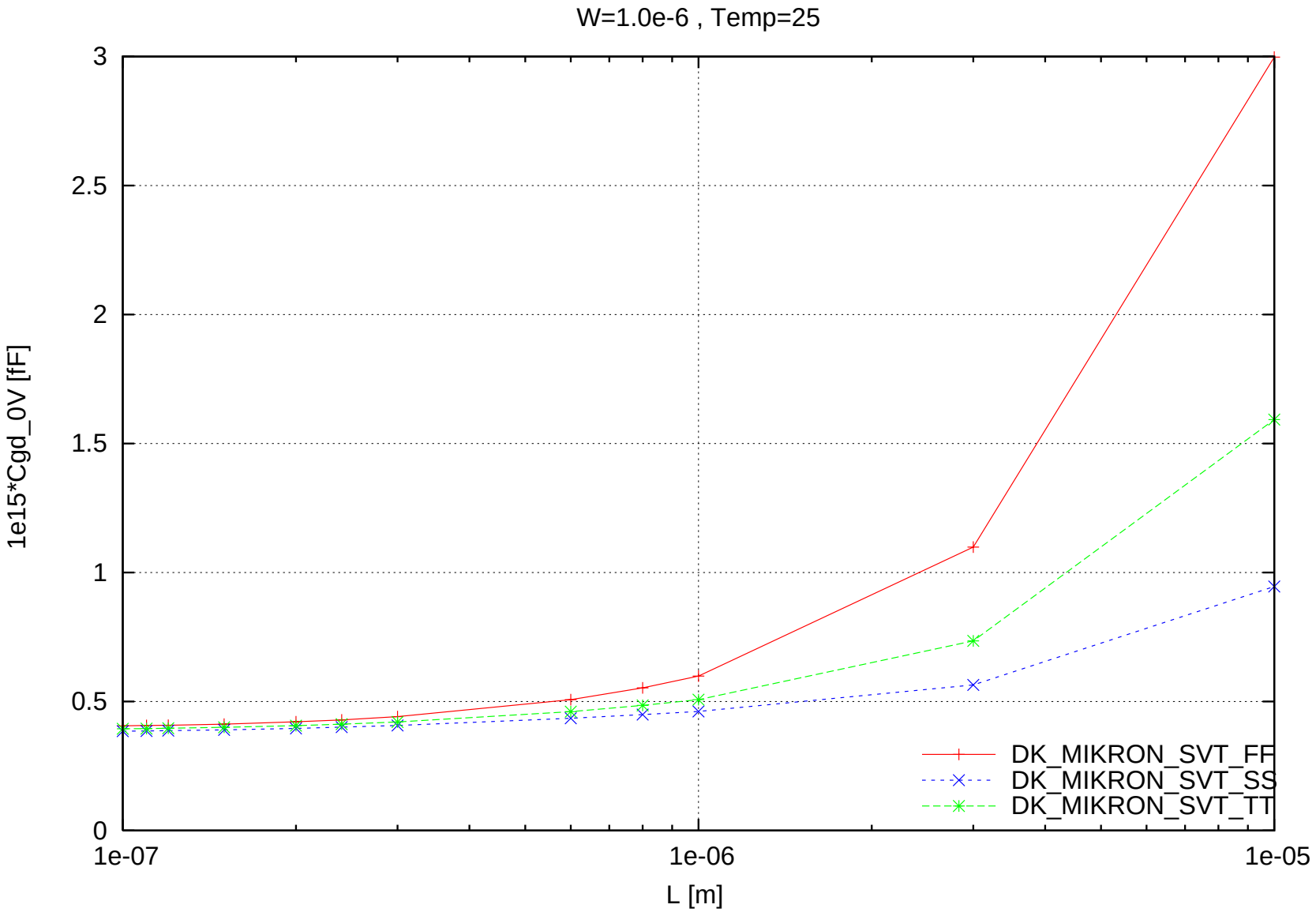
nsvt 1e15*Cgg_inv/(W*L*1e12) [fF/sq] vs. L [m] , W=1.0e-6 , Temp=25



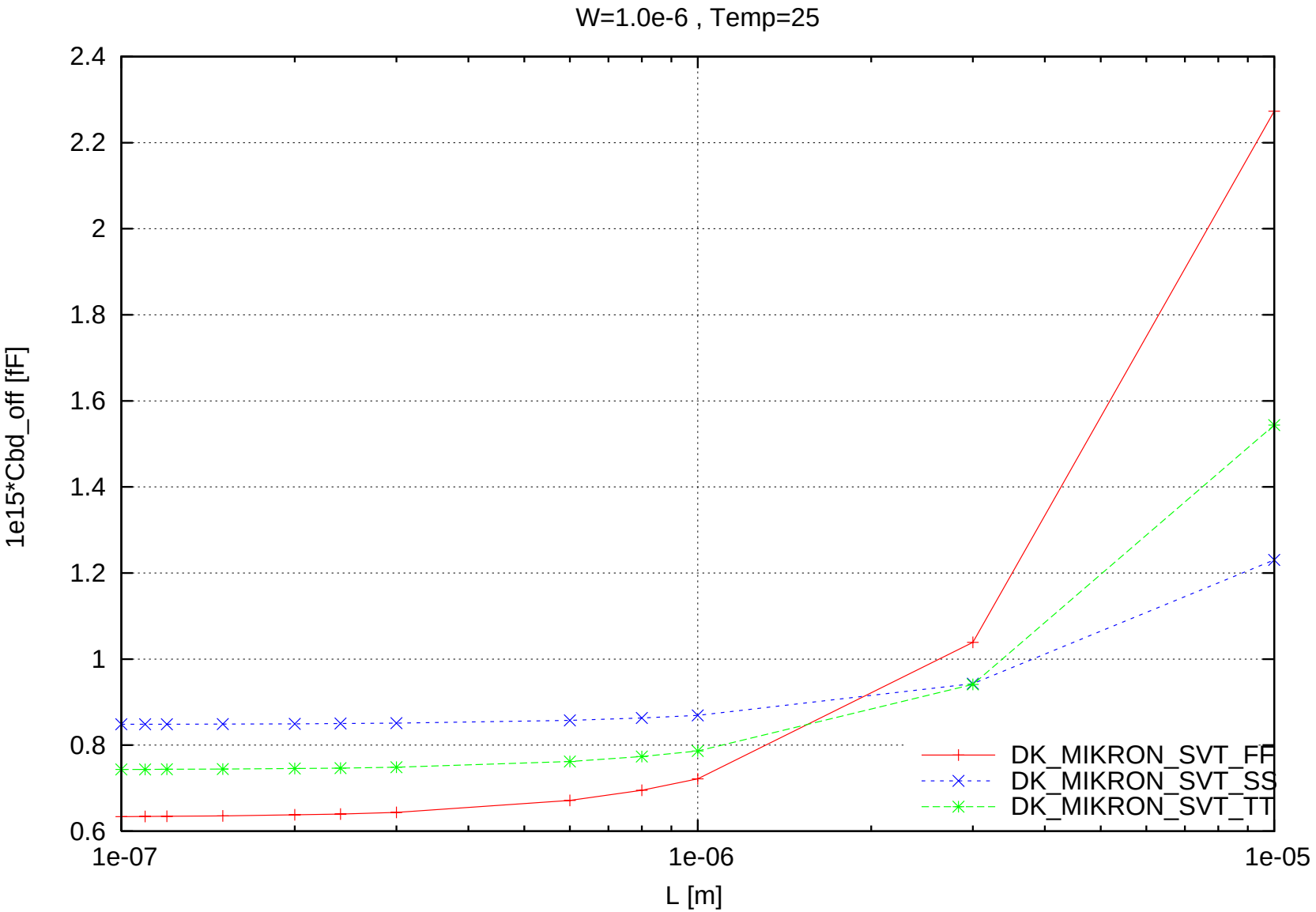
nsvt 1e15*Cggmean/(W*L*1e12) [fF/sq] vs. L [m] , W=1.0e-6 , Temp=25



nsvt 1e15*Cgd_0V [fF] vs. L [m] , W=1.0e-6 , Temp=25

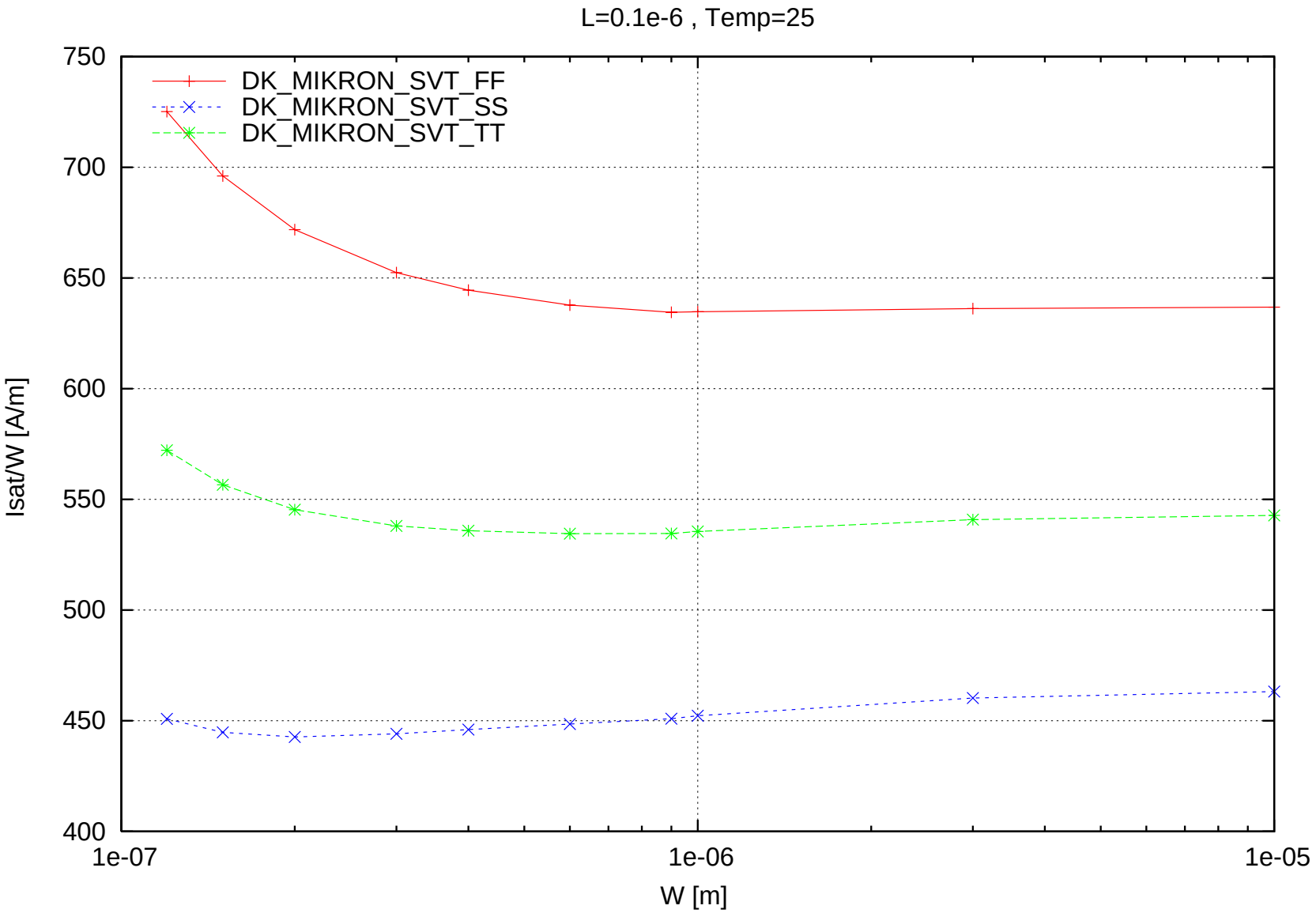


nsvt 1e15*Cbd_off [fF] vs. L [m] , W=1.0e-6 , Temp=25

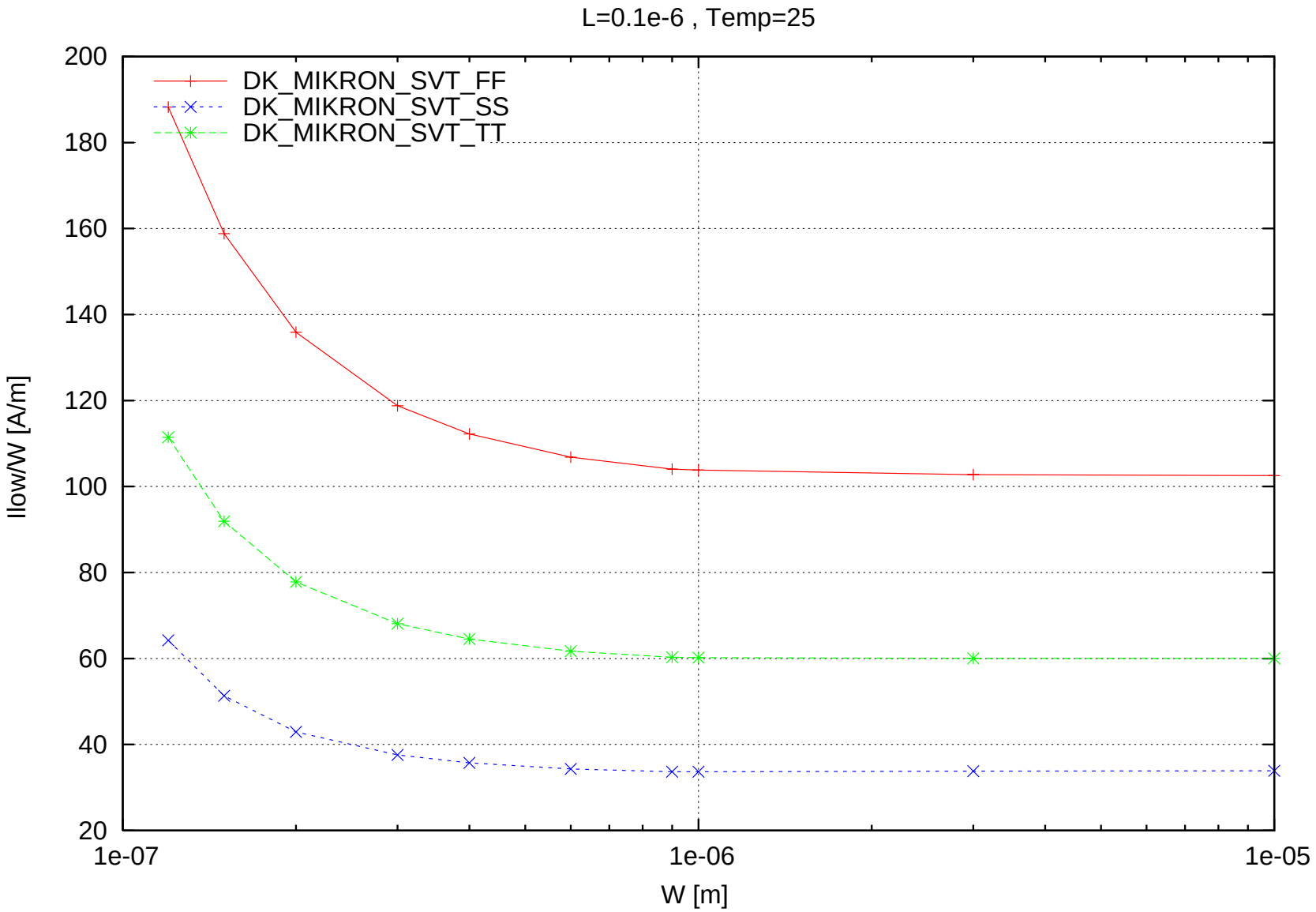


Scaling versus Width for NMOS (L=0.1e-6, Temp=25, po2act=0.63e-6, LPE=0)

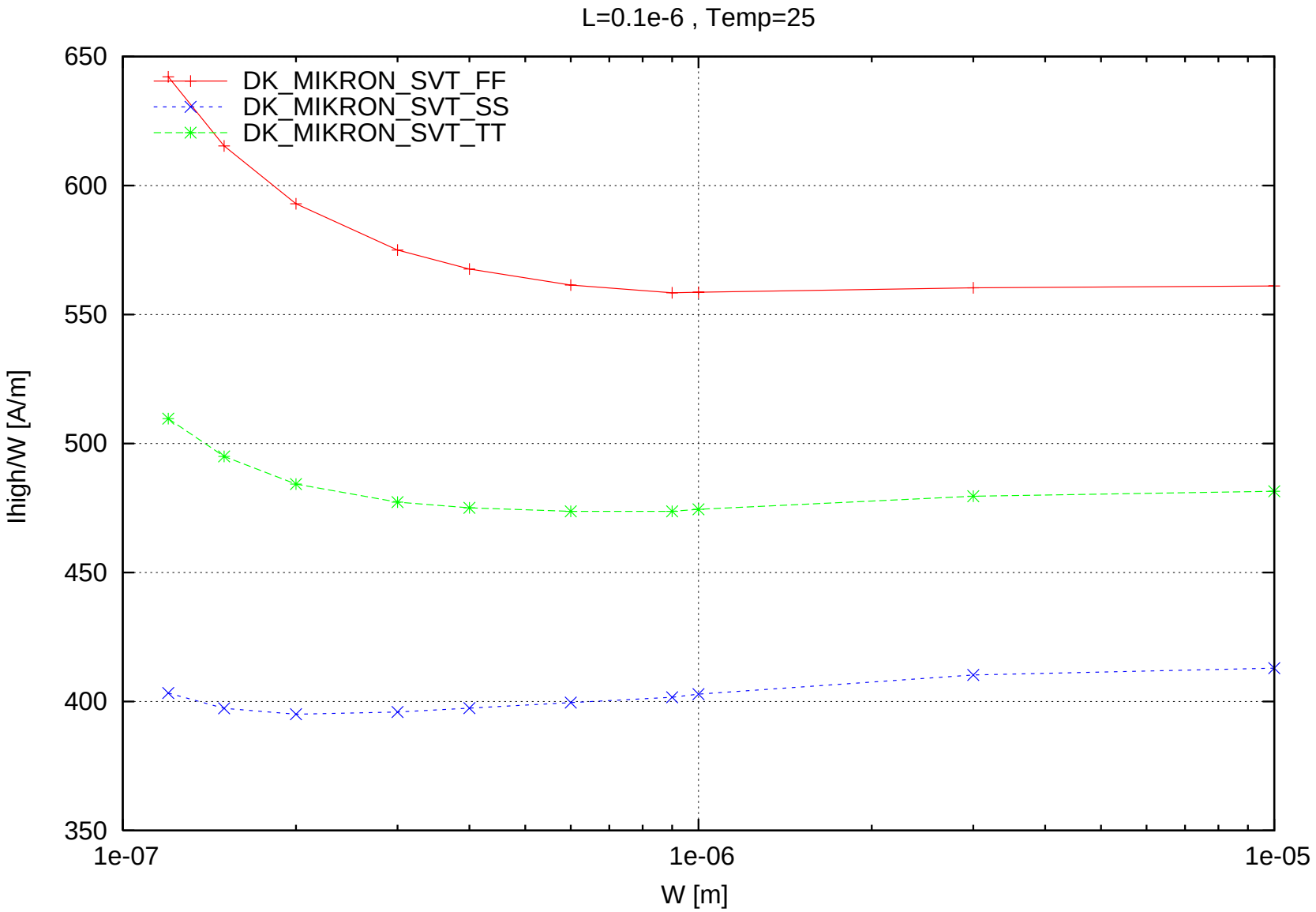
nsvt Isat/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



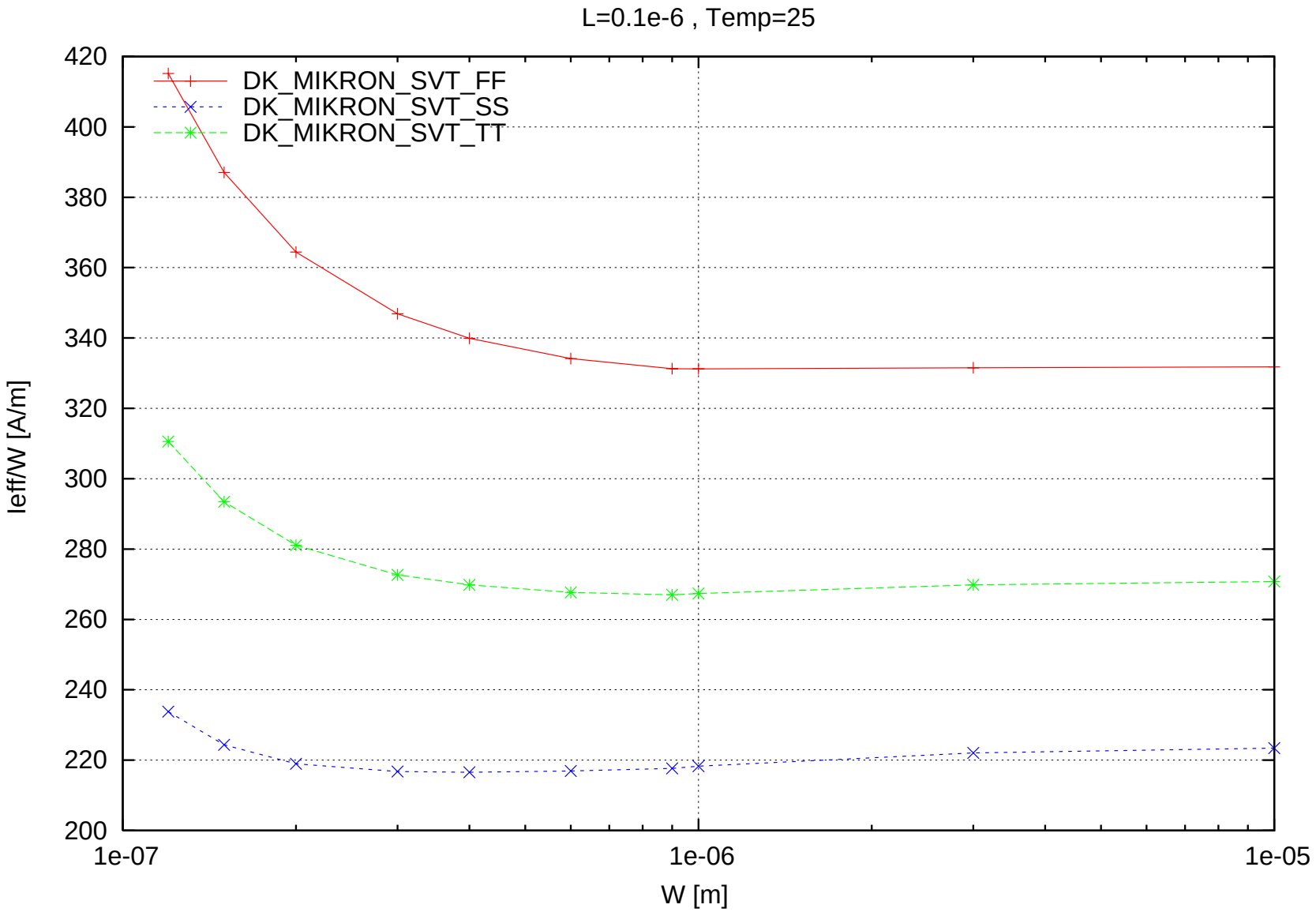
nsvt Ilow/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



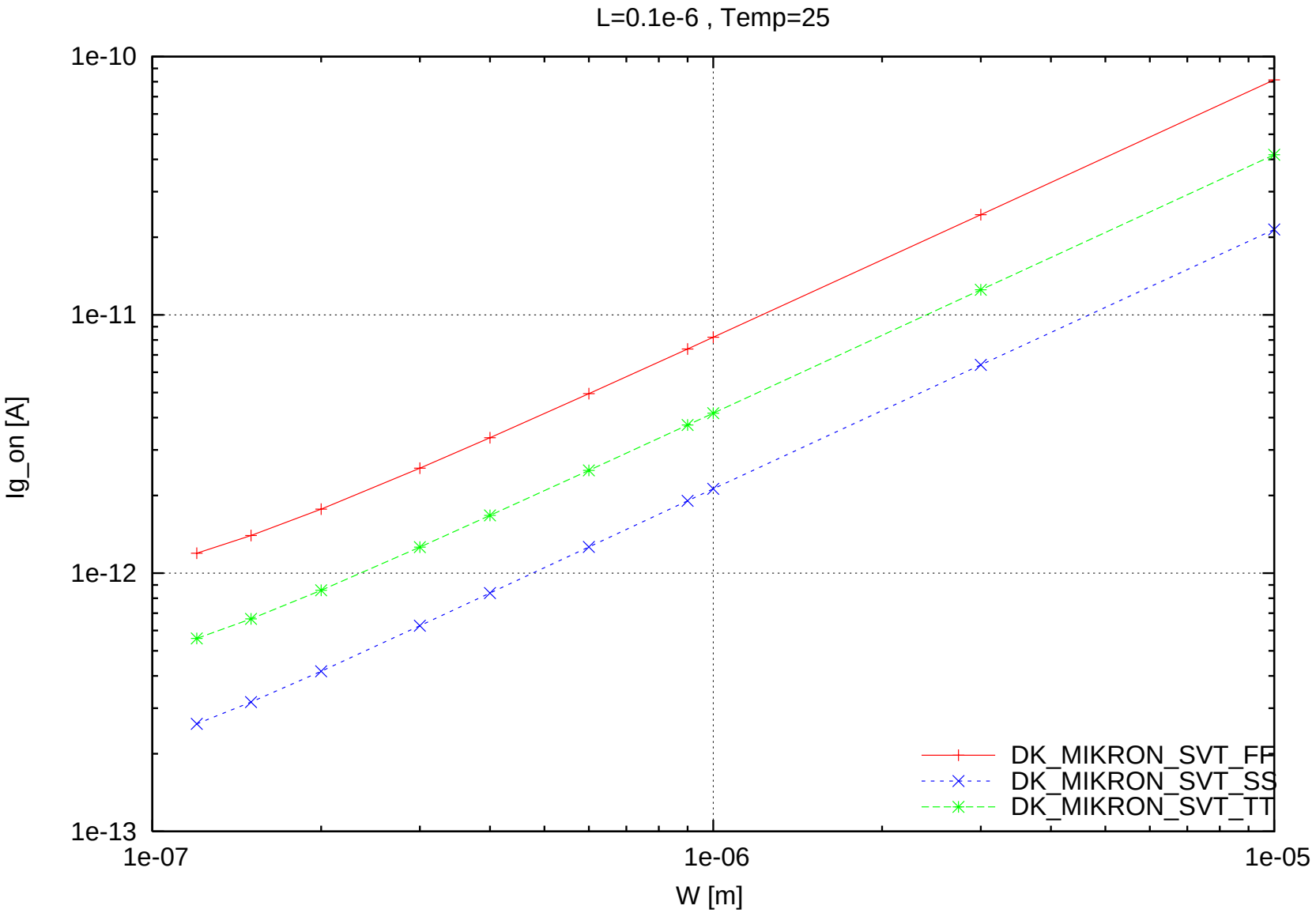
nsvt Ihigh/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



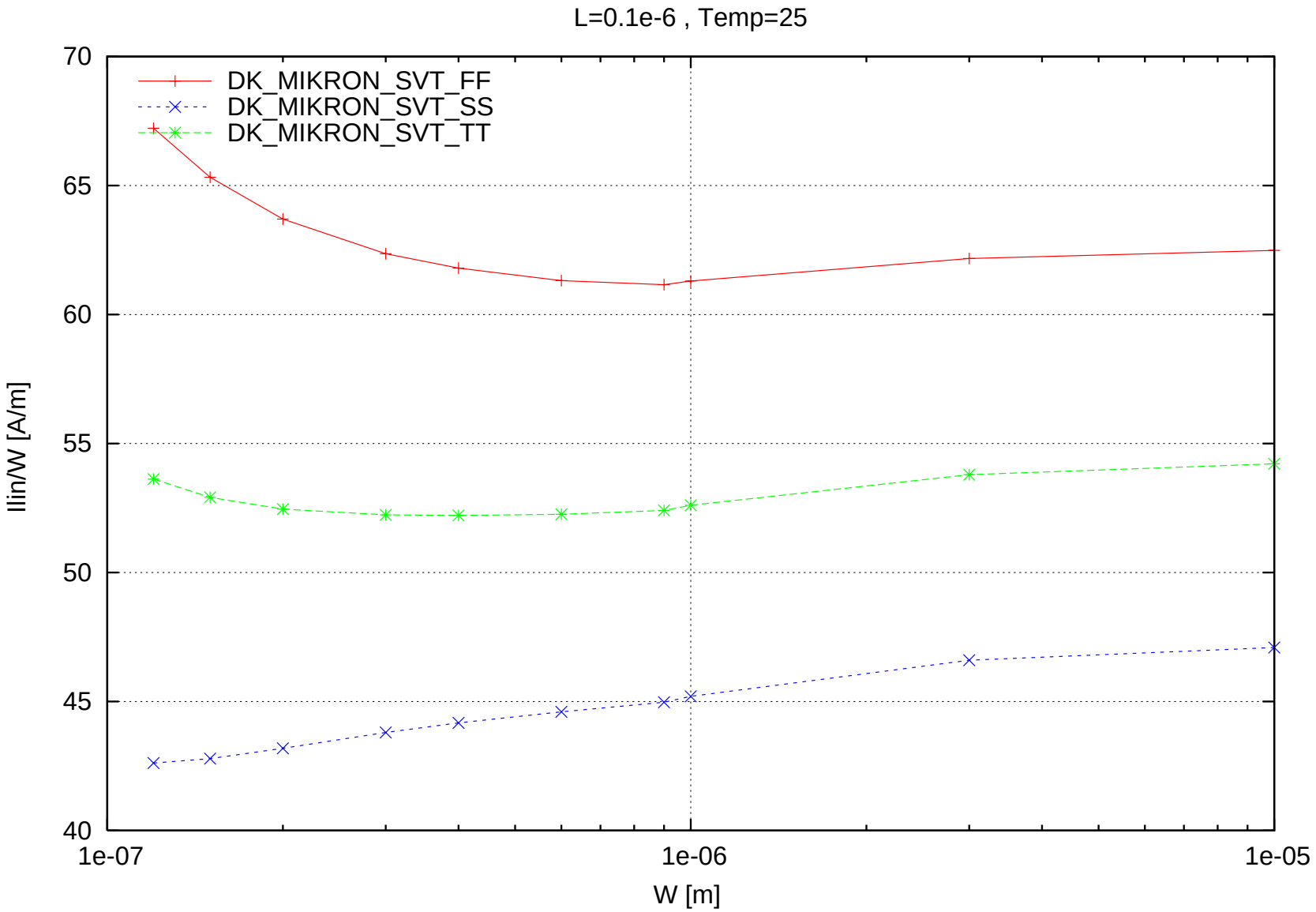
nsvt Ieff/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



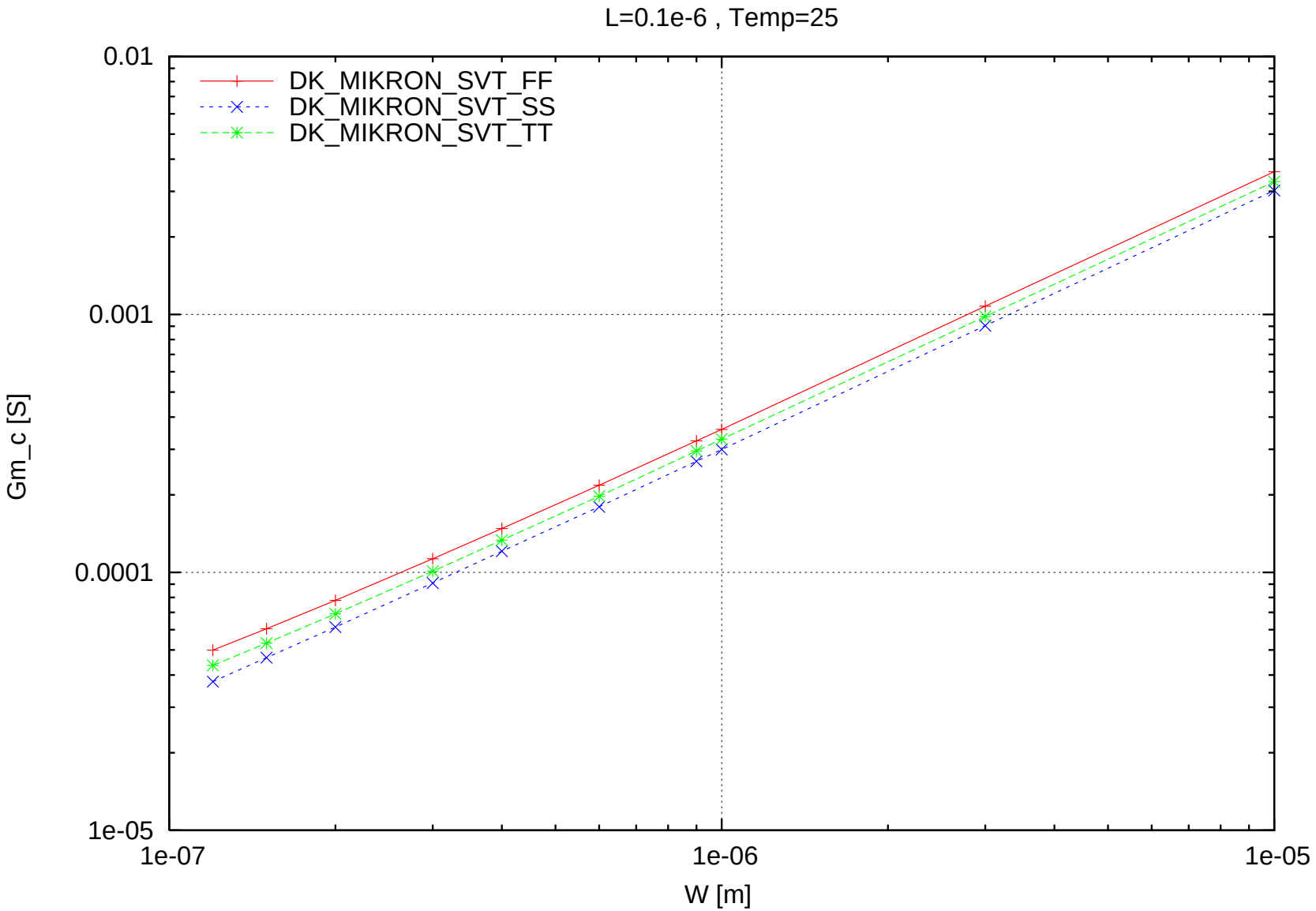
nsvt Ig_on [A] vs. W [m] , L=0.1e-6 , Temp=25



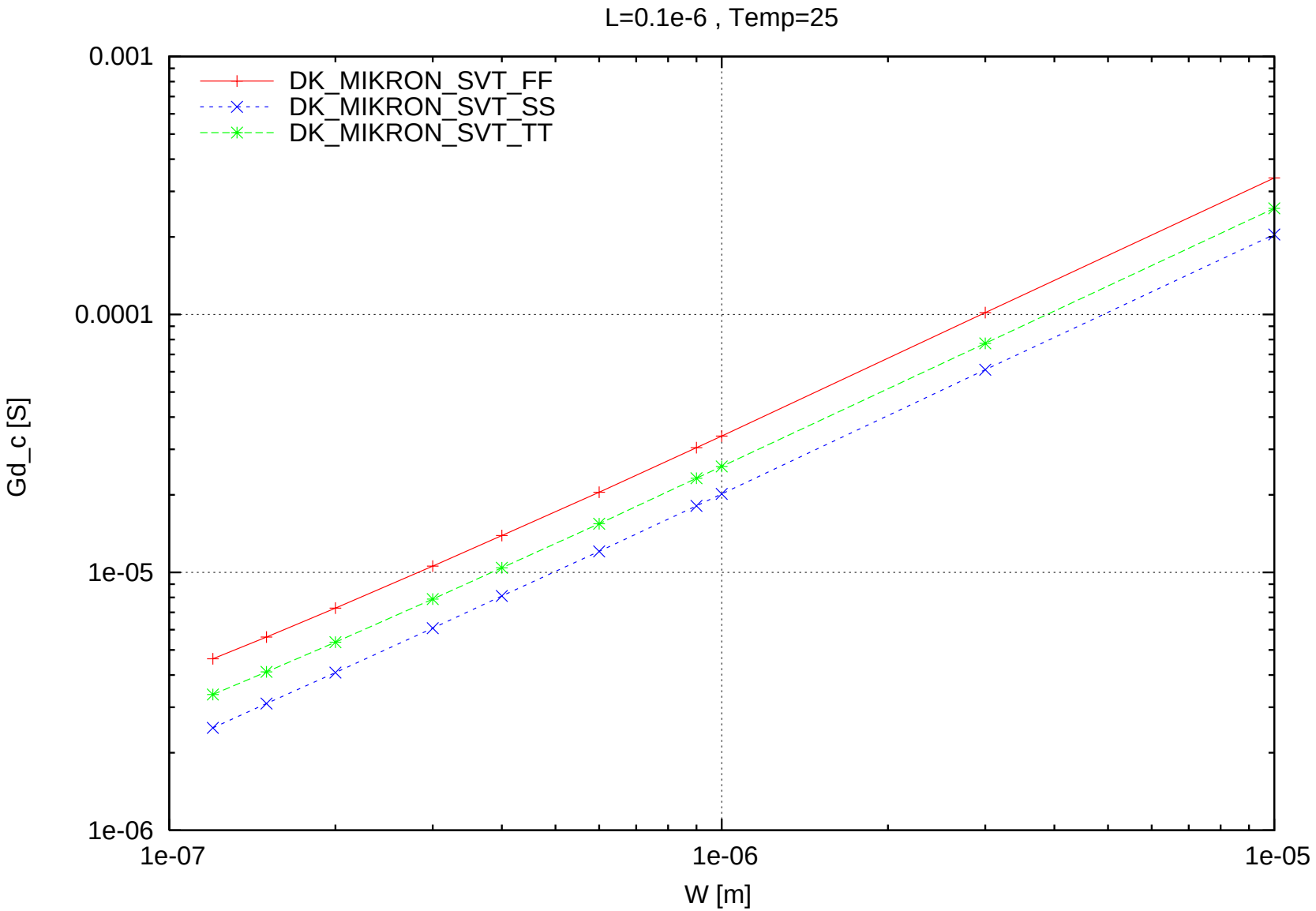
nsvt Ilin/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



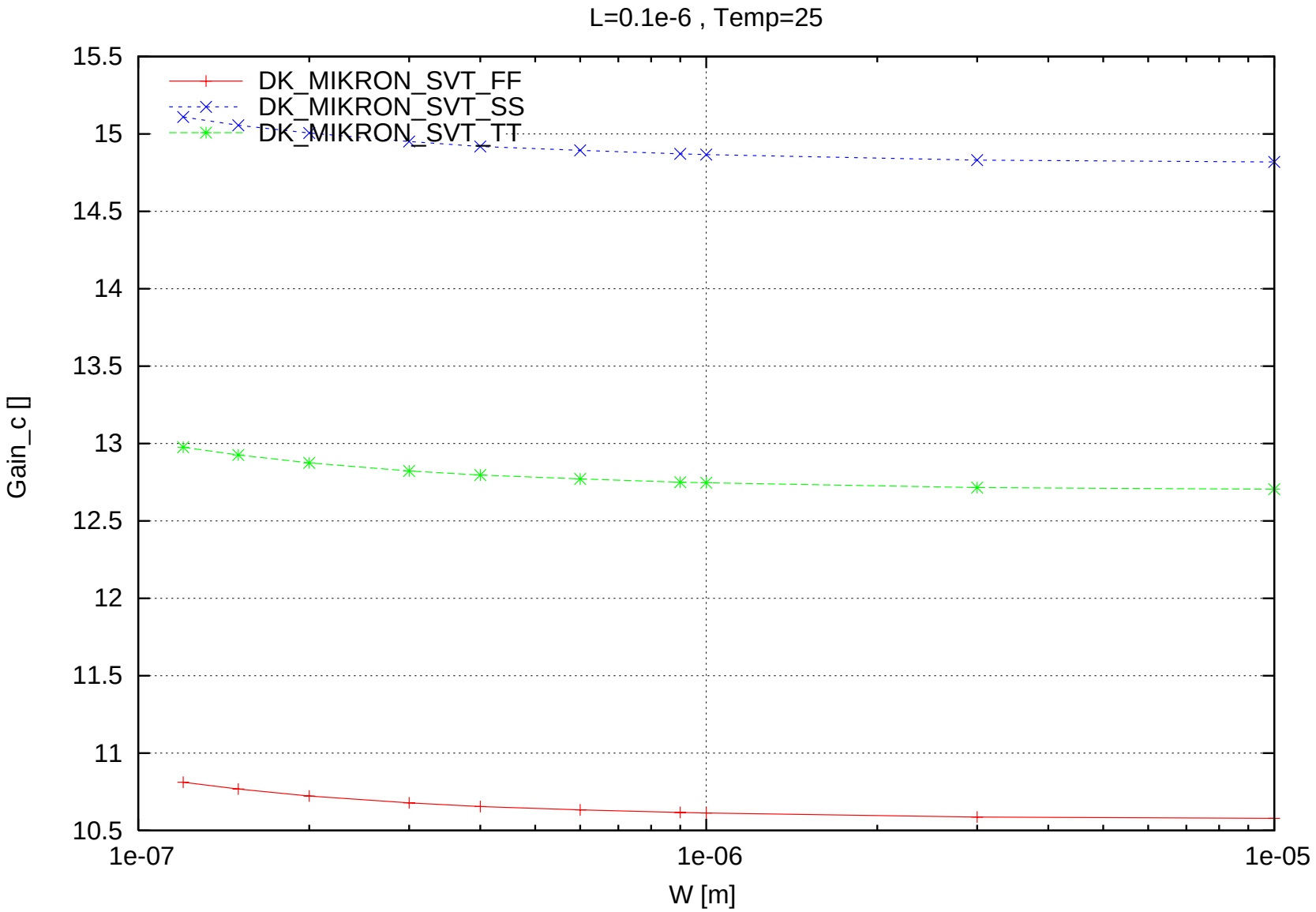
nsvt Gm_c [S] vs. W [m] , L=0.1e-6 , Temp=25



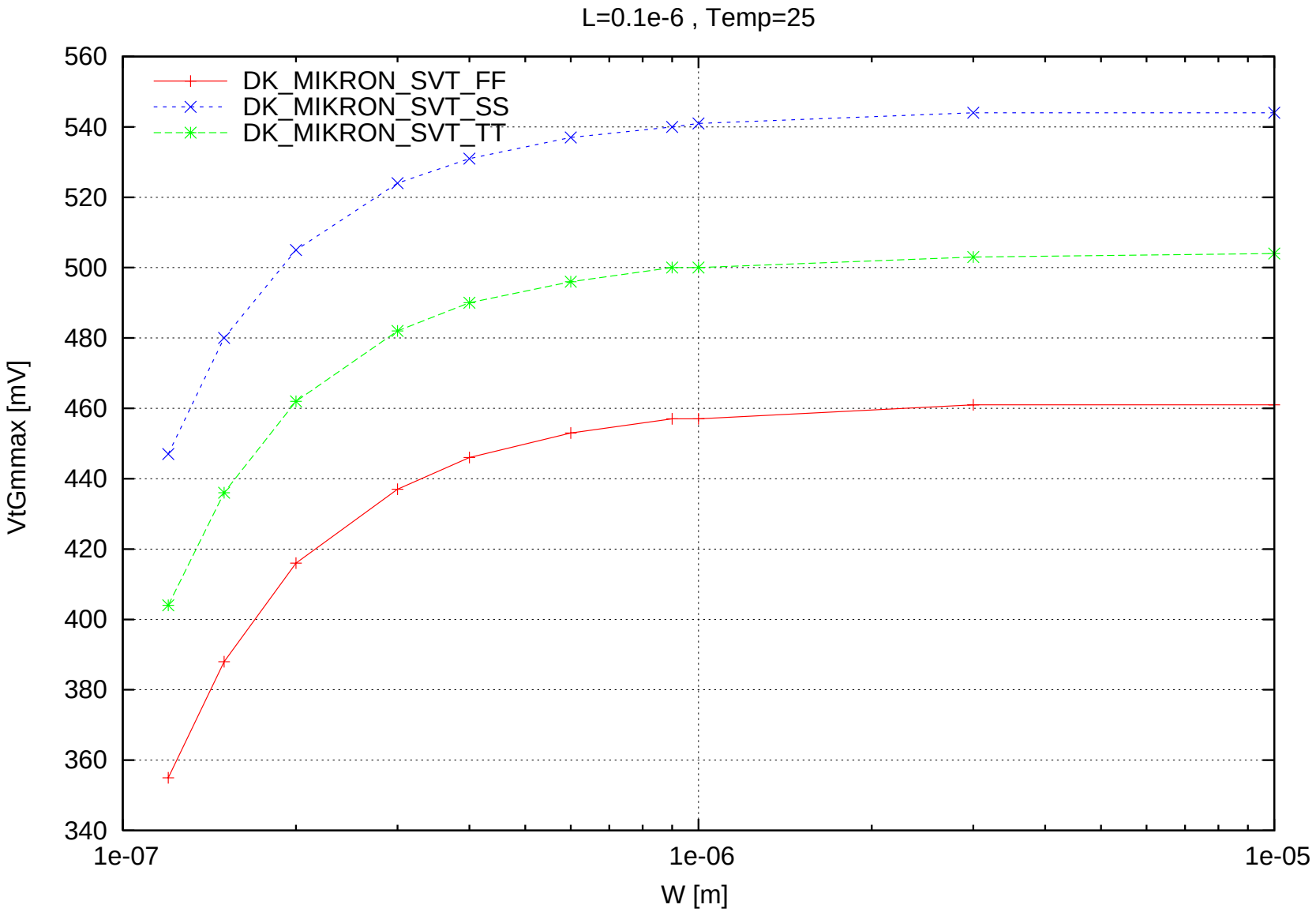
nsvt Gd_c [S] vs. W [m] , L=0.1e-6 , Temp=25



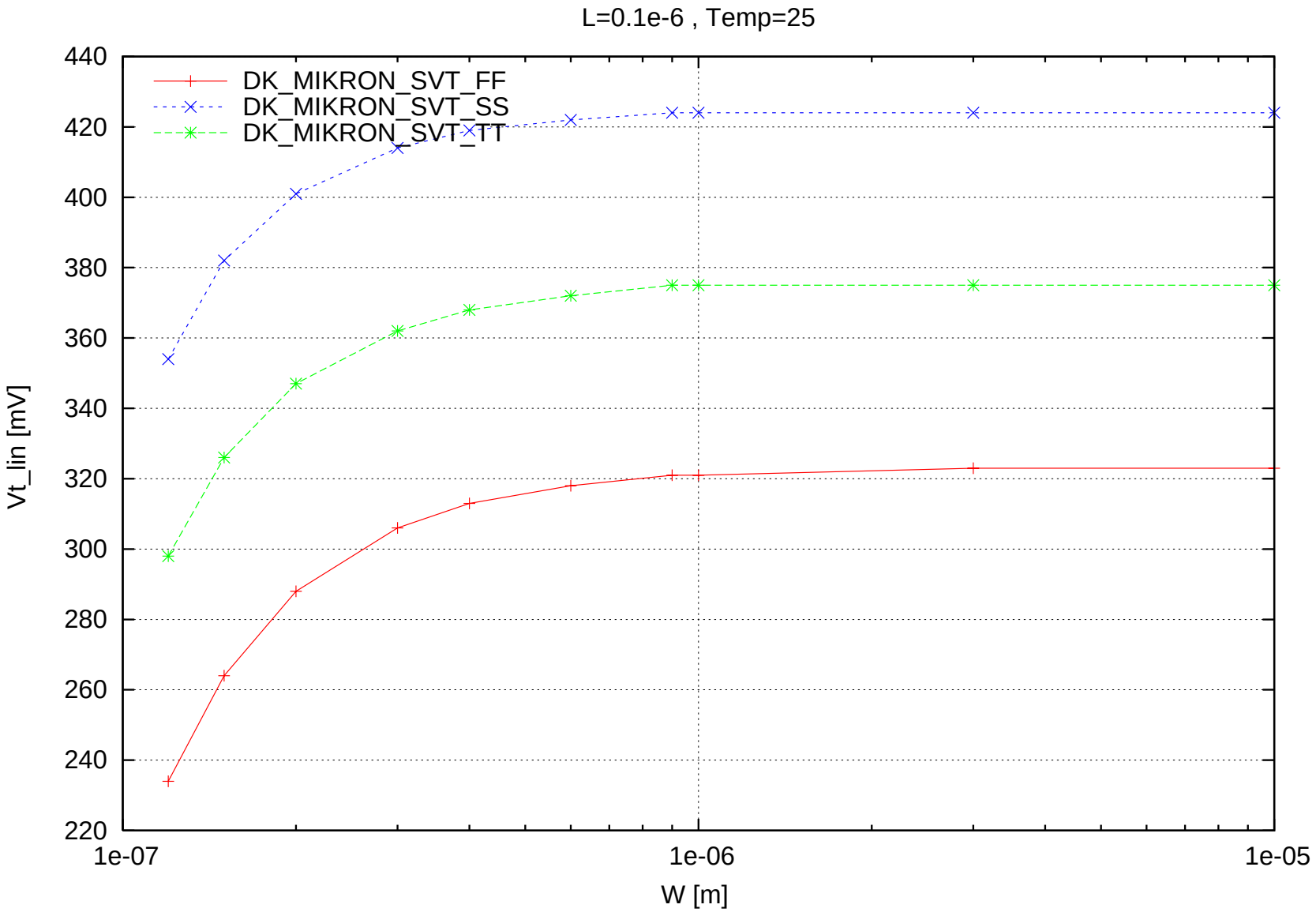
nsvt Gain_c [] vs. W [m] , L=0.1e-6 , Temp=25



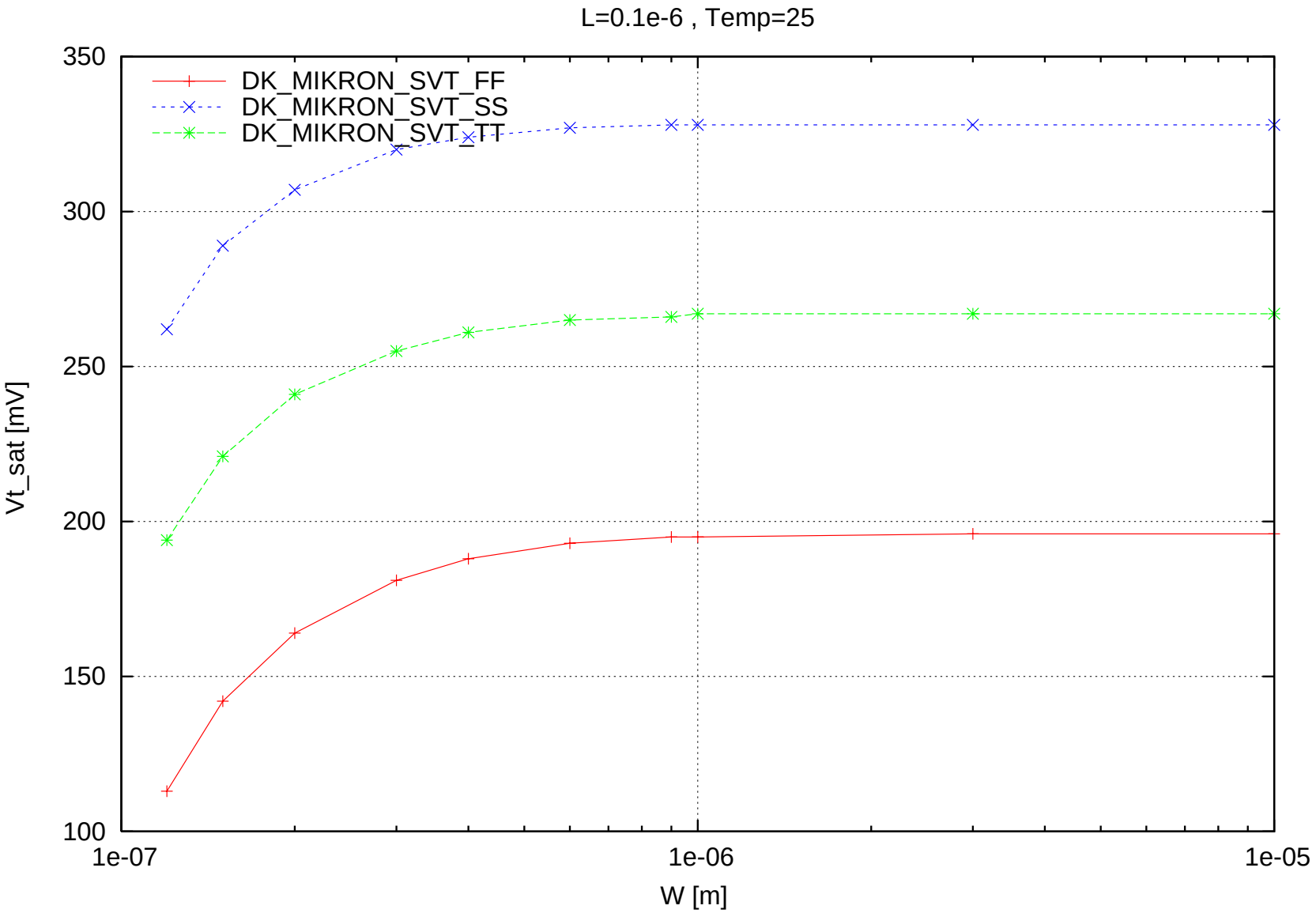
nsvt VtGmmax [mV] vs. W [m] , L=0.1e-6 , Temp=25



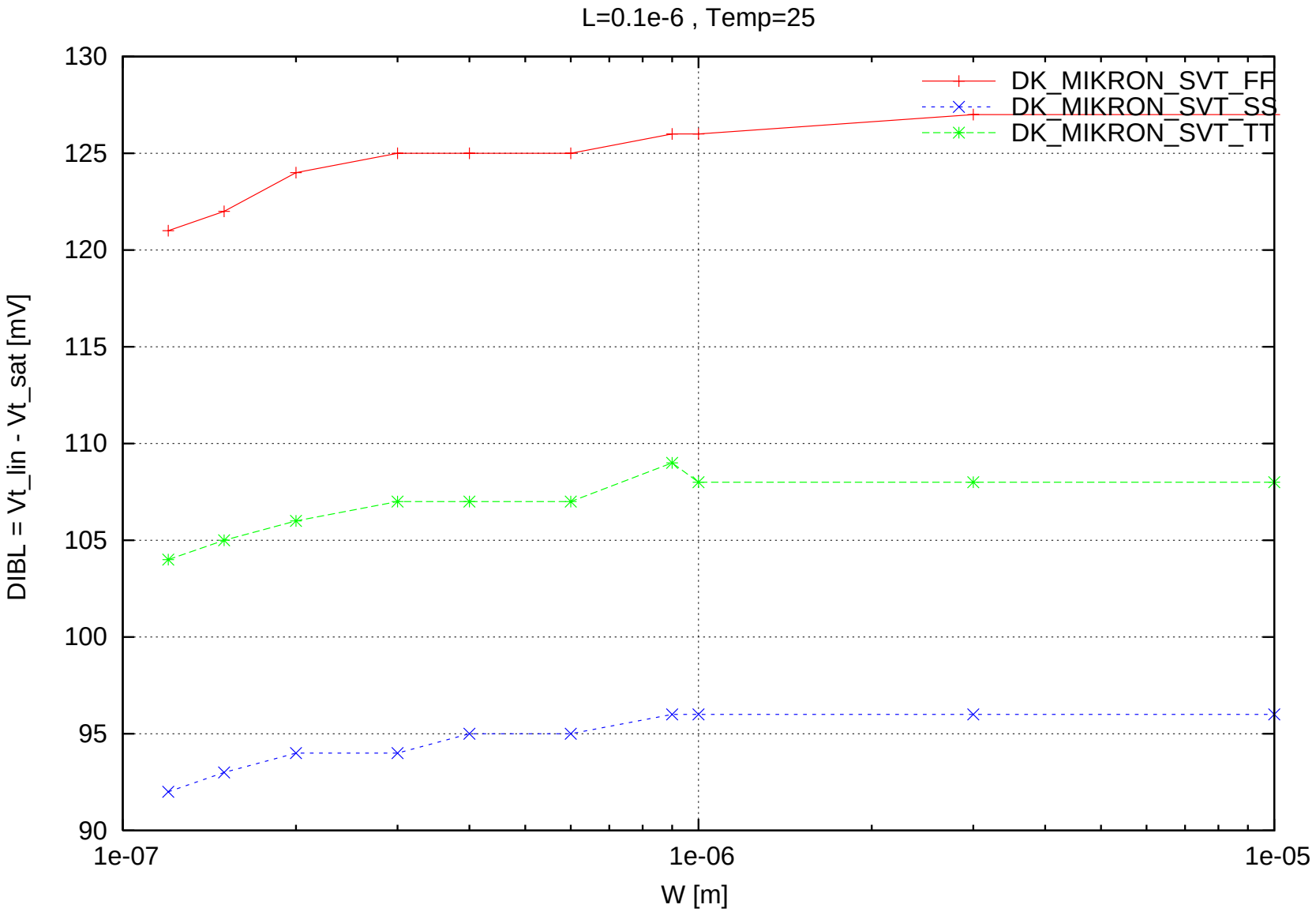
nsvt Vt_lin [mV] vs. W [m] , L=0.1e-6 , Temp=25



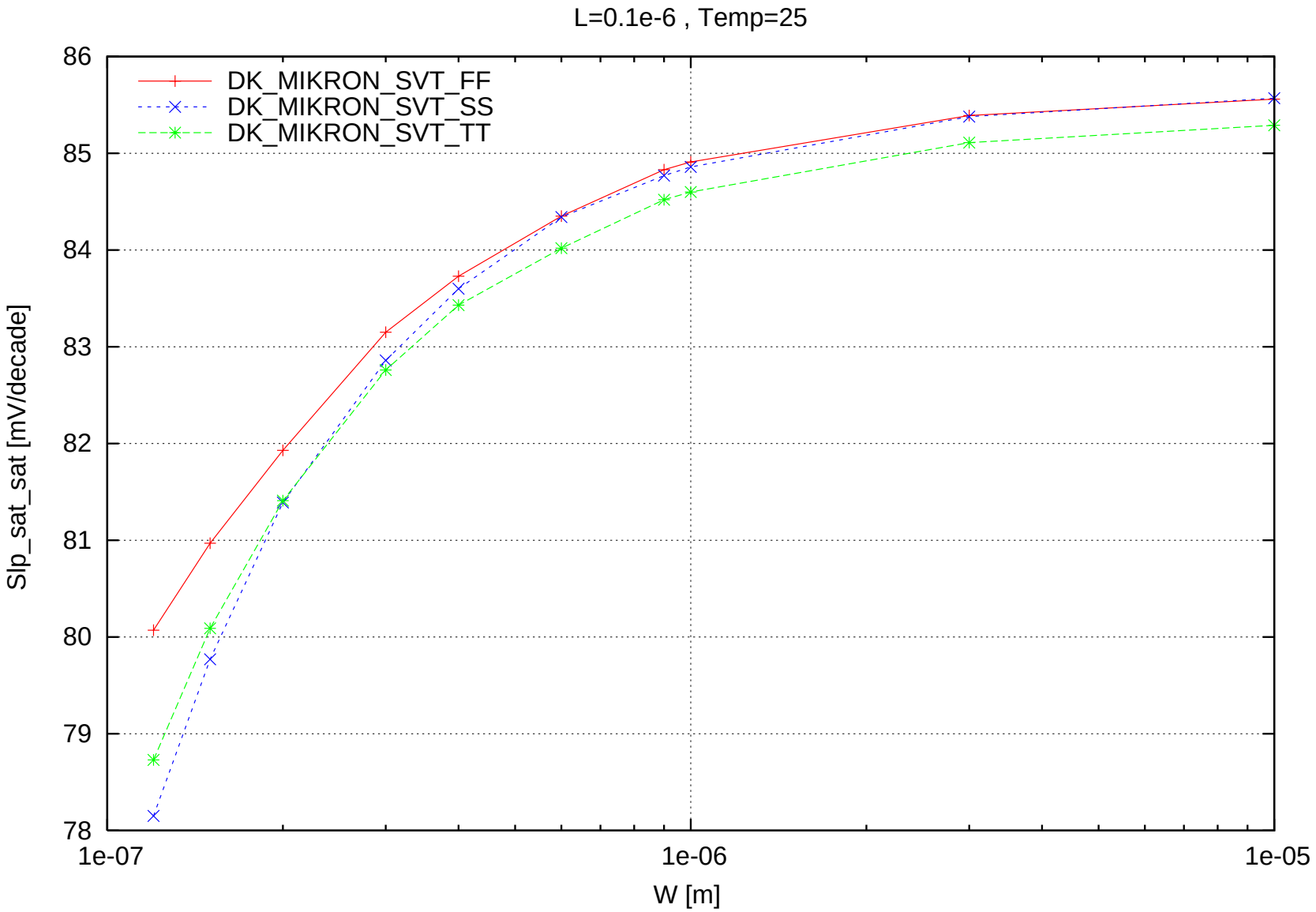
nsvt Vt_sat [mV] vs. W [m] , L=0.1e-6 , Temp=25



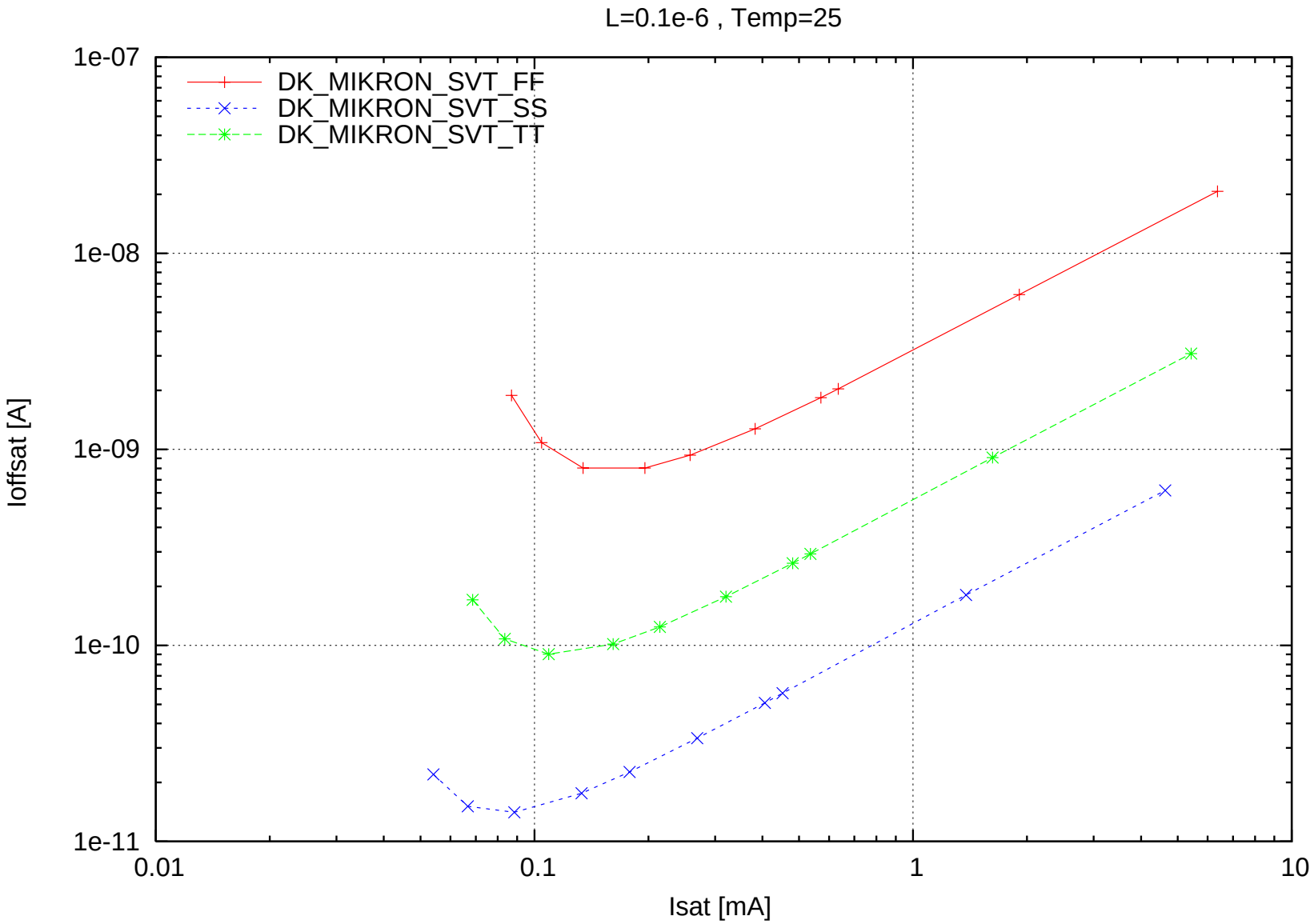
nsvt DIBL = Vt_lin - Vt_sat [mV] vs. W [m] , L=0.1e-6 , Temp=25



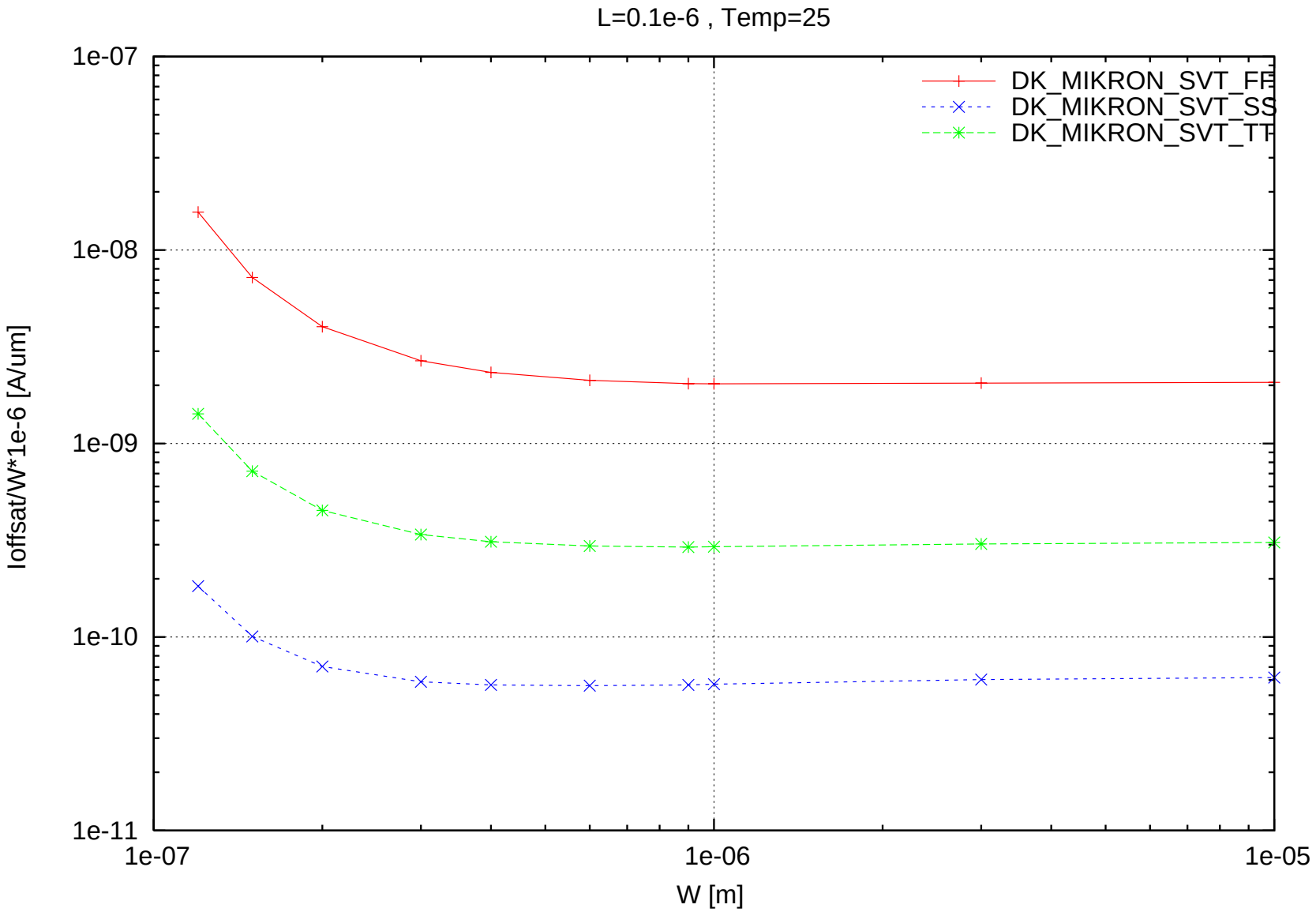
nsvt Slp_sat_sat [mV/decade] vs. W [m] , L=0.1e-6 , Temp=25



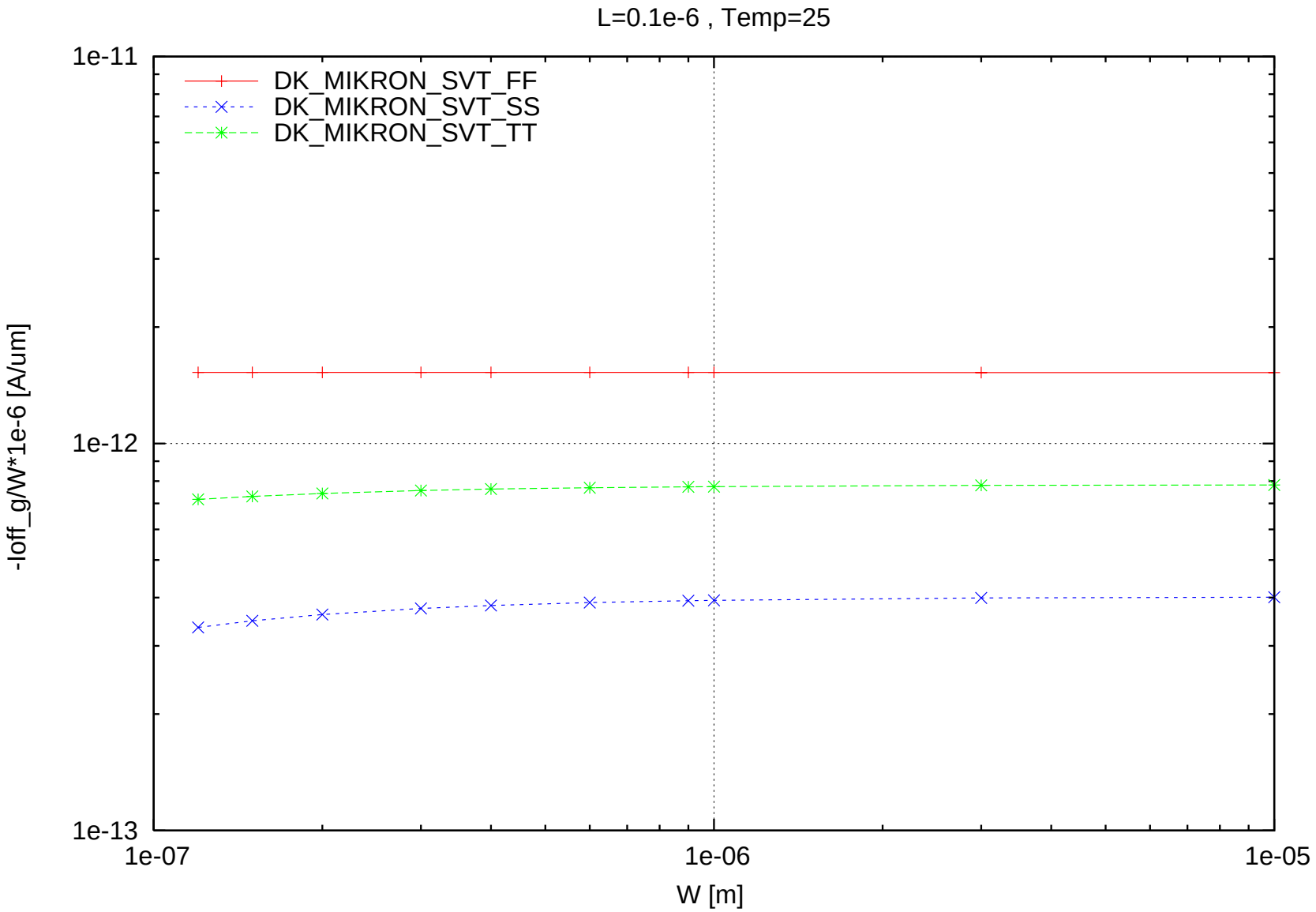
nsvt Ioffsat [A] vs. Isat [mA] , L=0.1e-6 , Temp=25



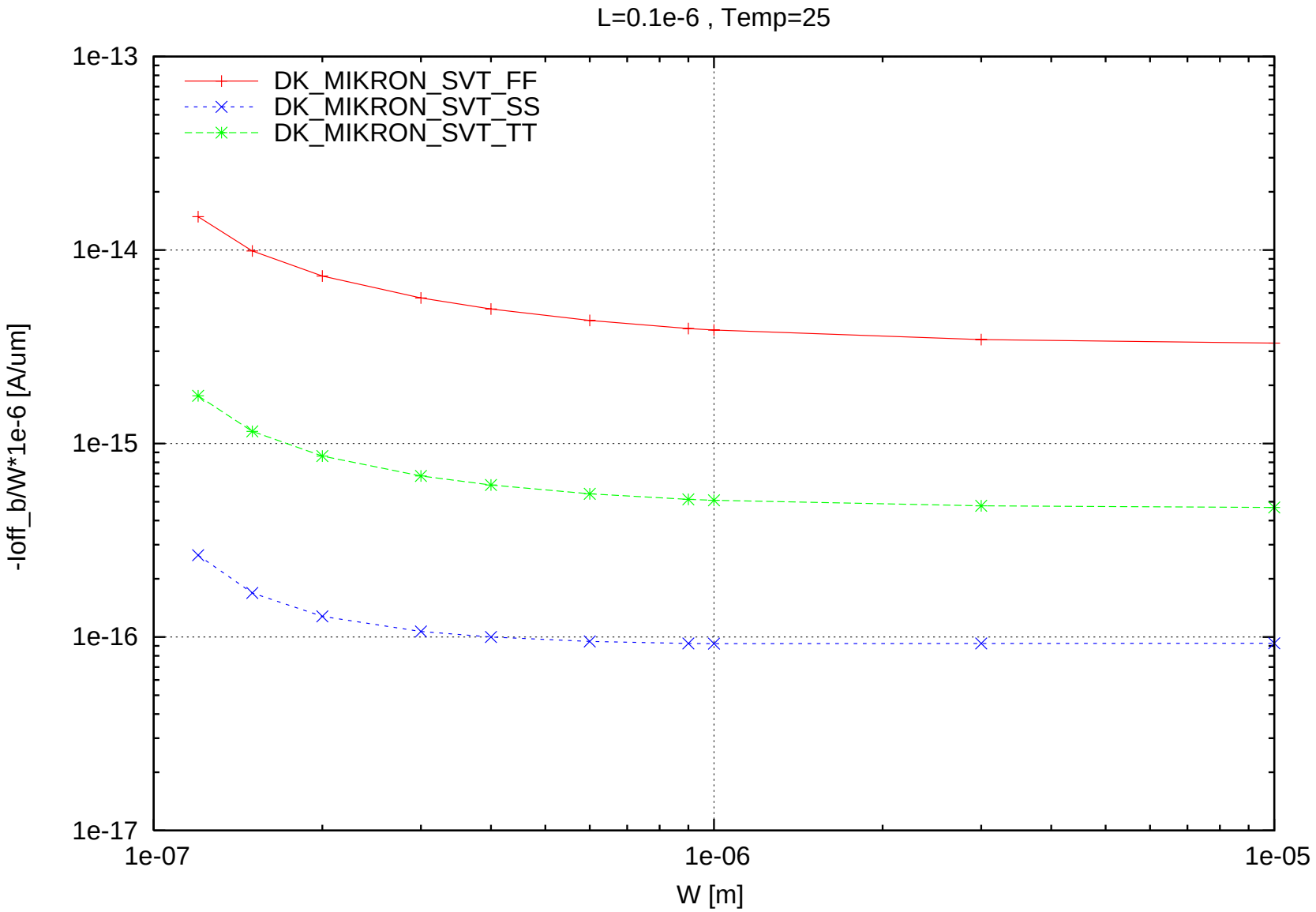
nsvt Ioffsat/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



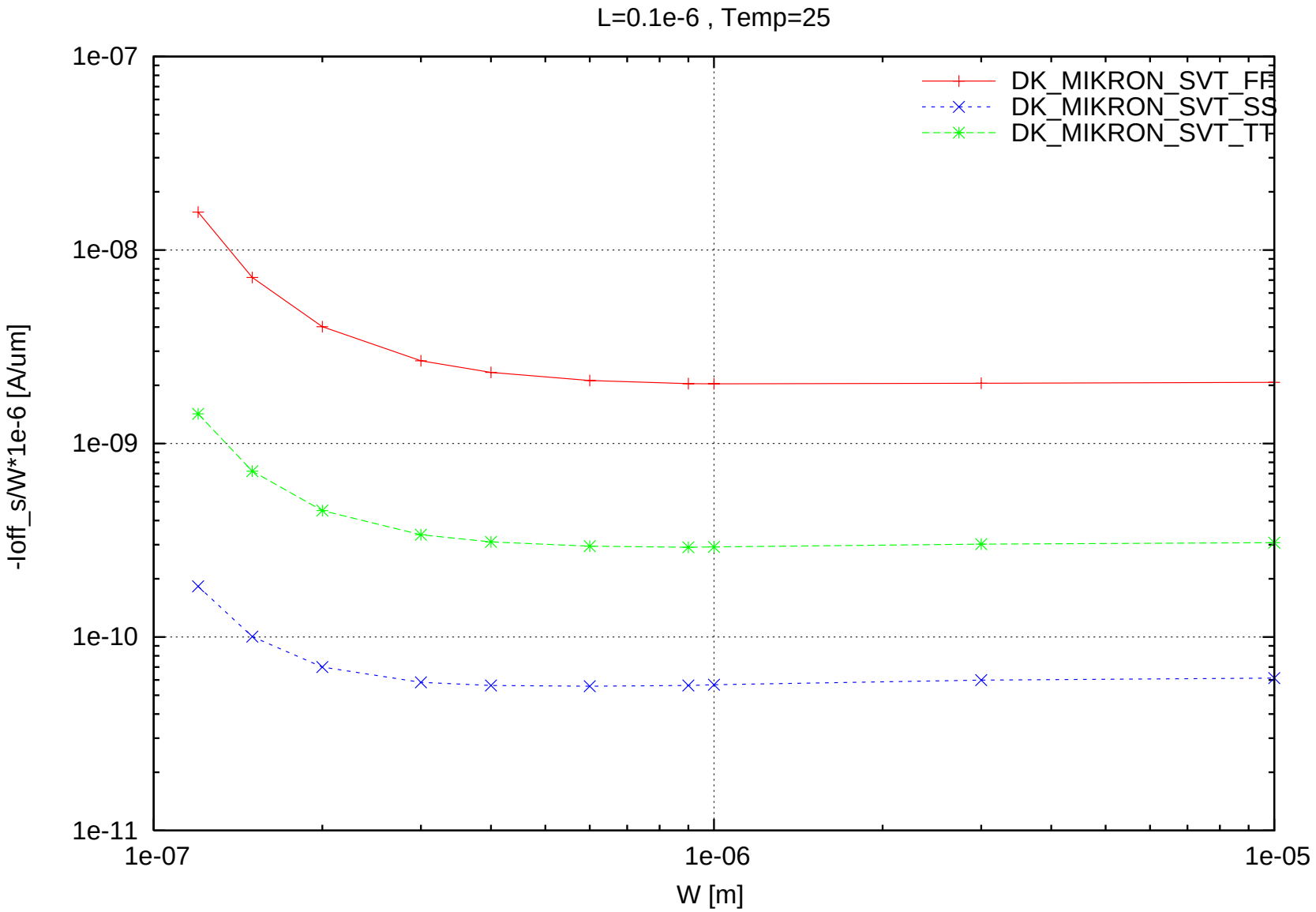
nsvt -Ioff_g/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



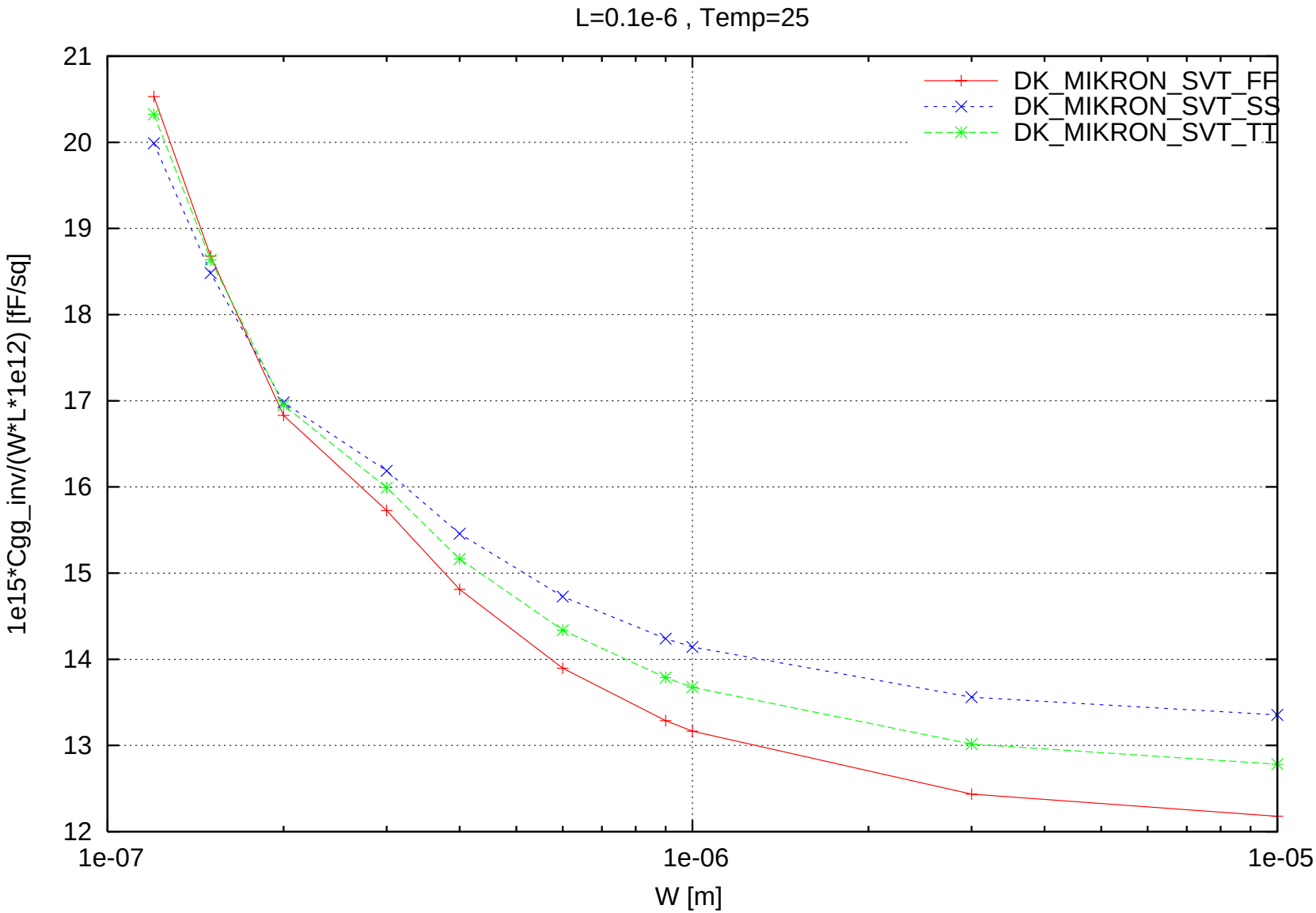
nsvt -Ioff_b/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



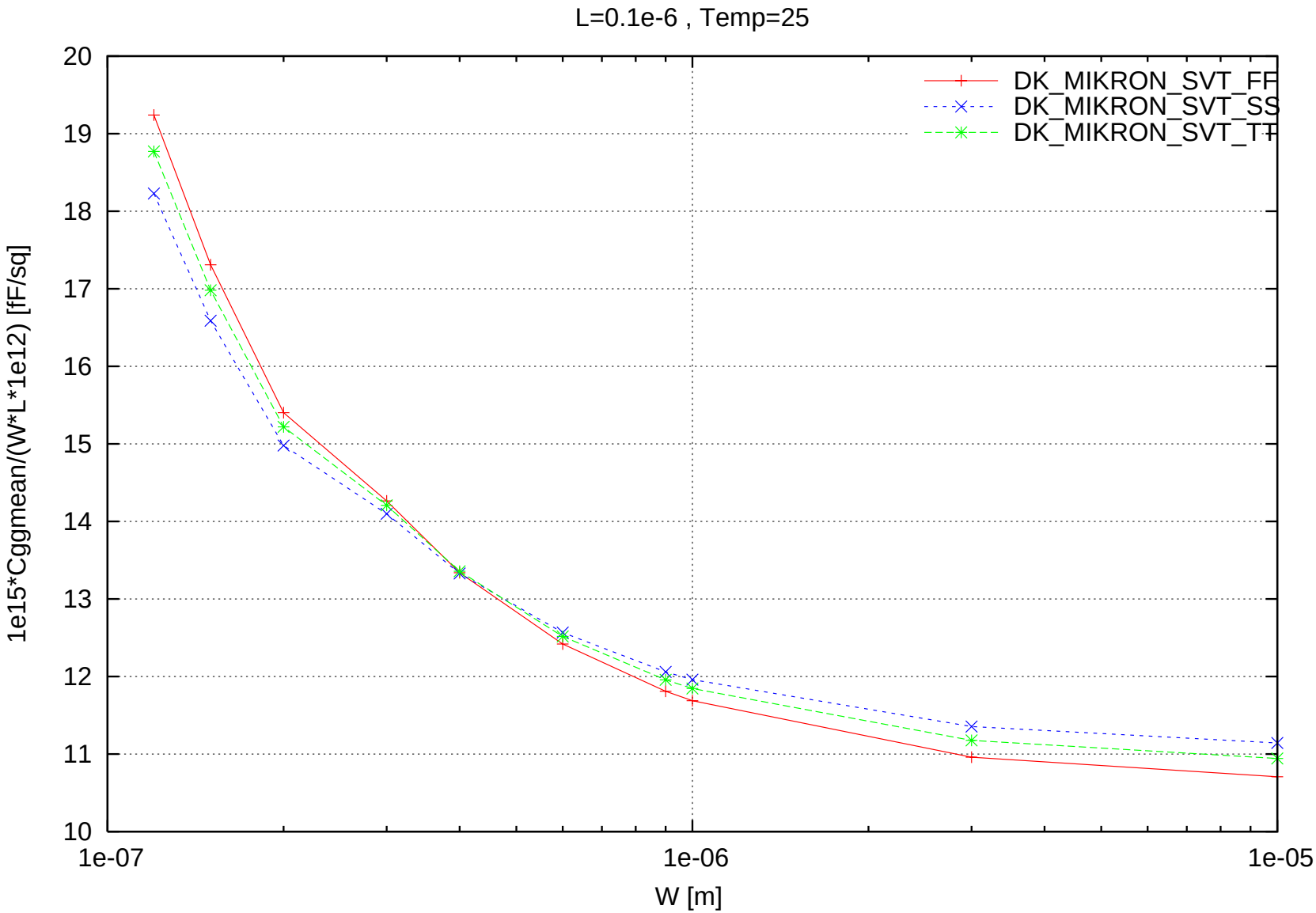
nsvt -Ioff_s/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



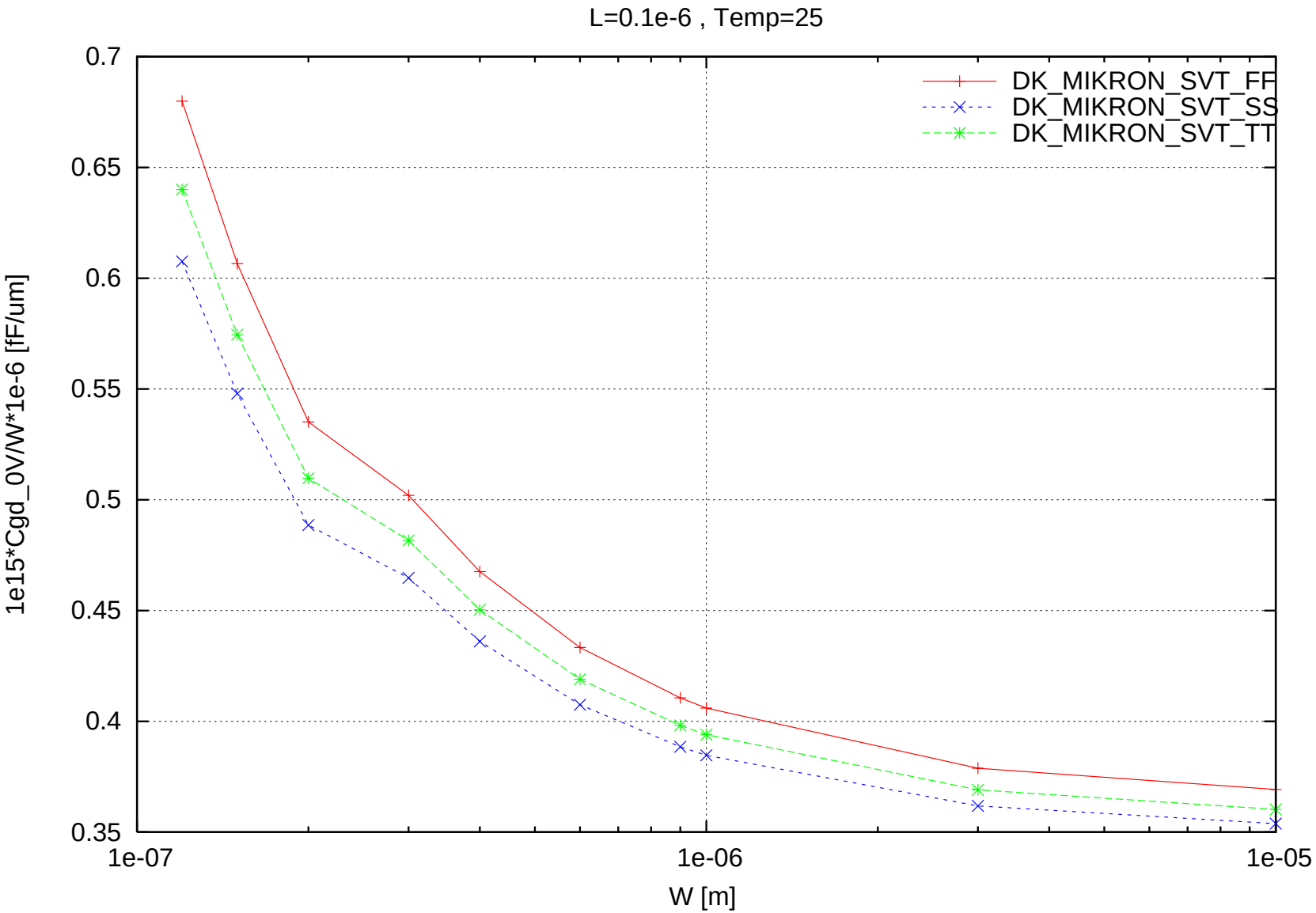
nsvt 1e15*Cgg_inv/(W*L*1e12) [fF/sq] vs. W [m] , L=0.1e-6 , Temp=25



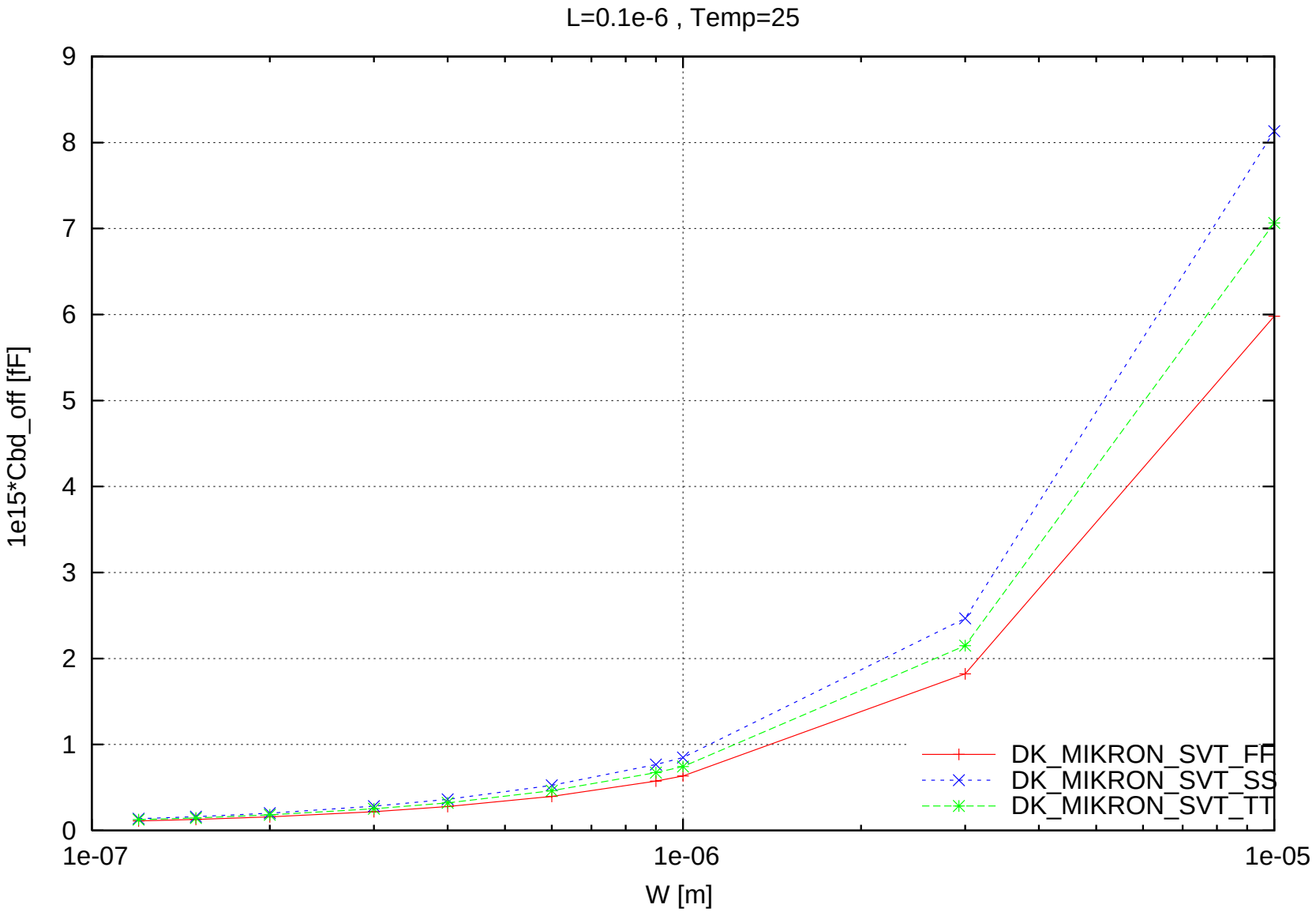
nsvt 1e15*Cggmean/(W*L*1e12) [fF/sq] vs. W [m] , L=0.1e-6 , Temp=25



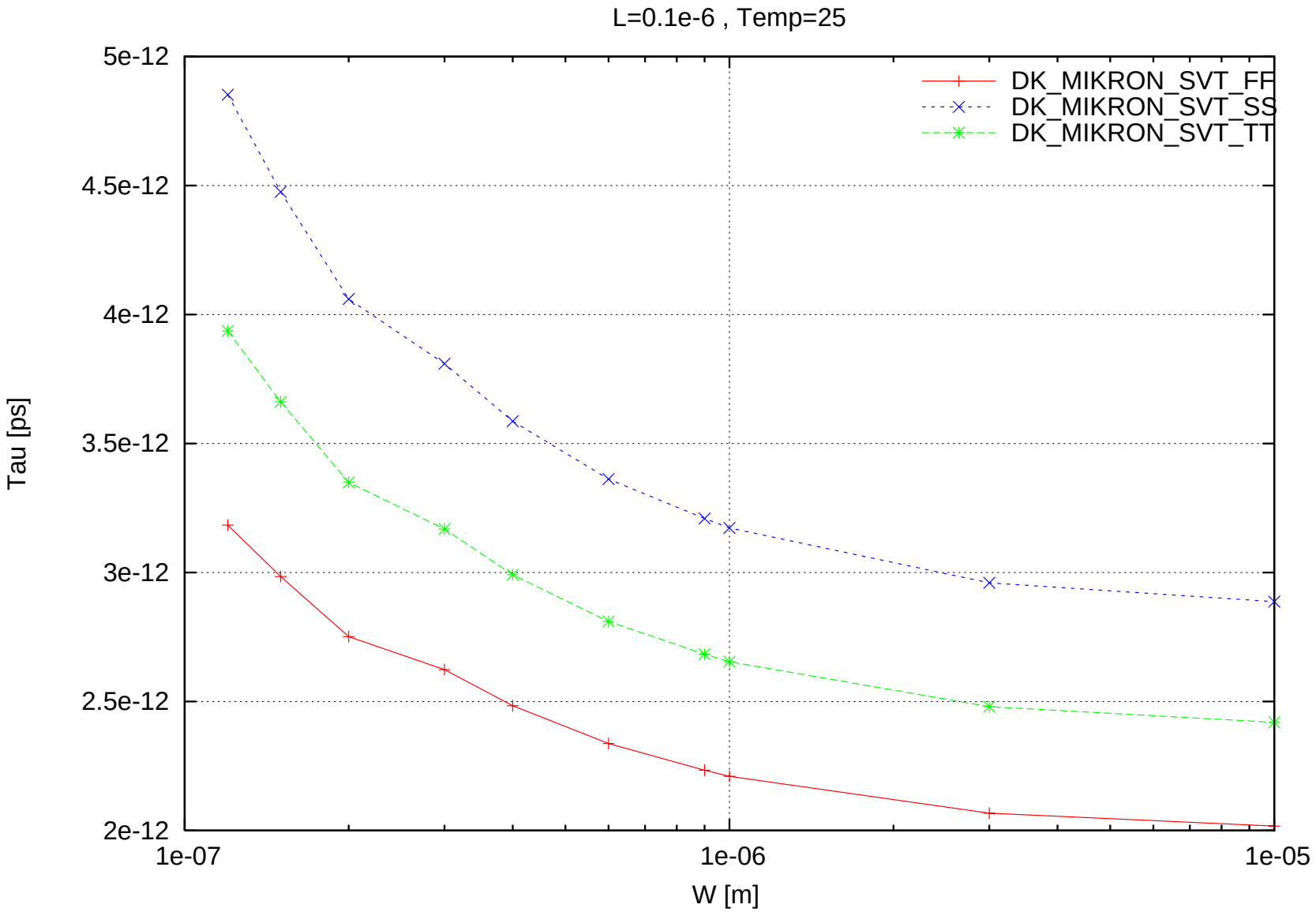
nsvt 1e15*Cgd_0V/W*1e-6 [fF/um] vs. W [m] , L=0.1e-6 , Temp=25



nsvt 1e15*Cbd_off [fF] vs. W [m] , L=0.1e-6 , Temp=25

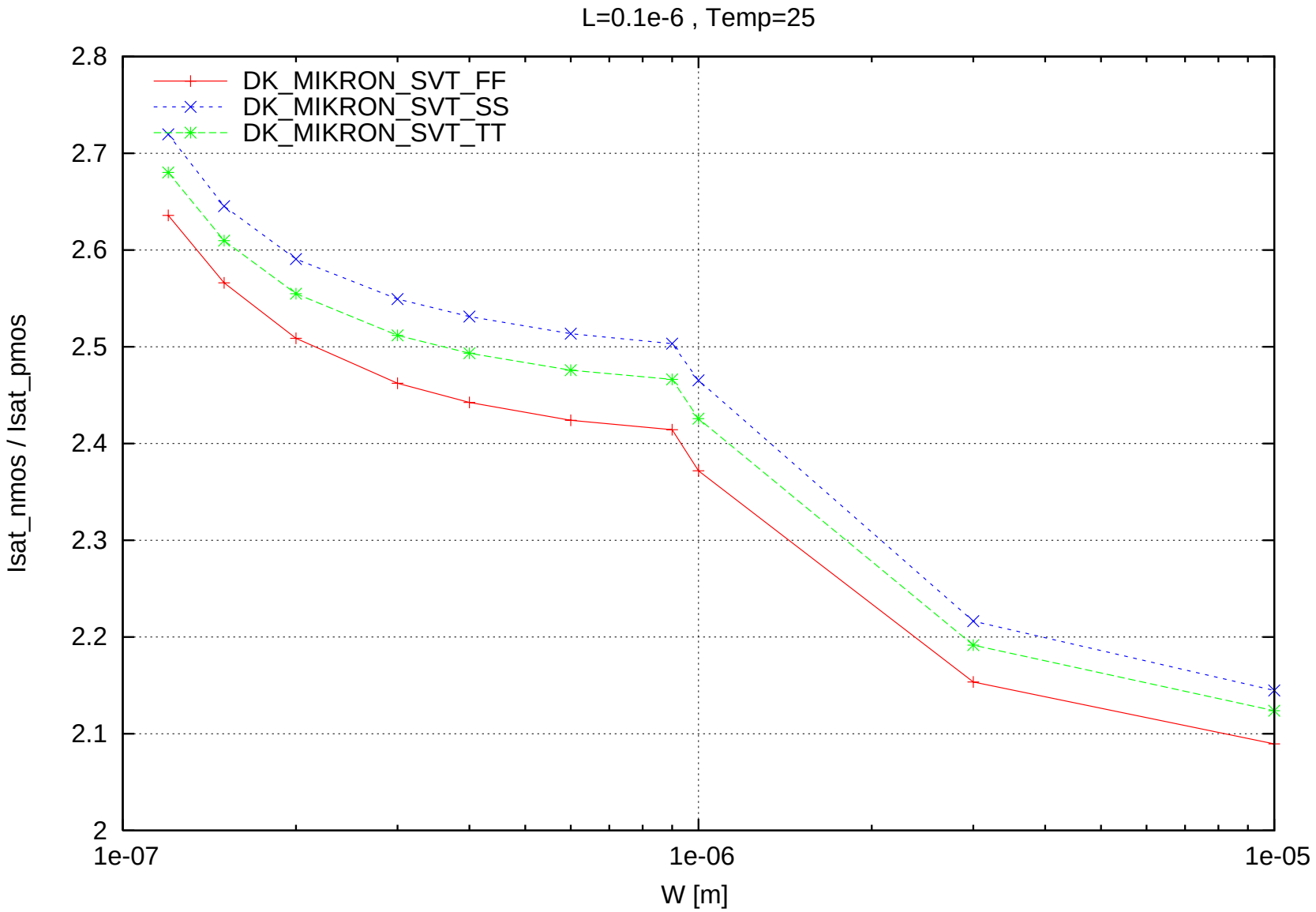


nsvt Tau [ps] vs. W [m] , L=0.1e-6 , Temp=25

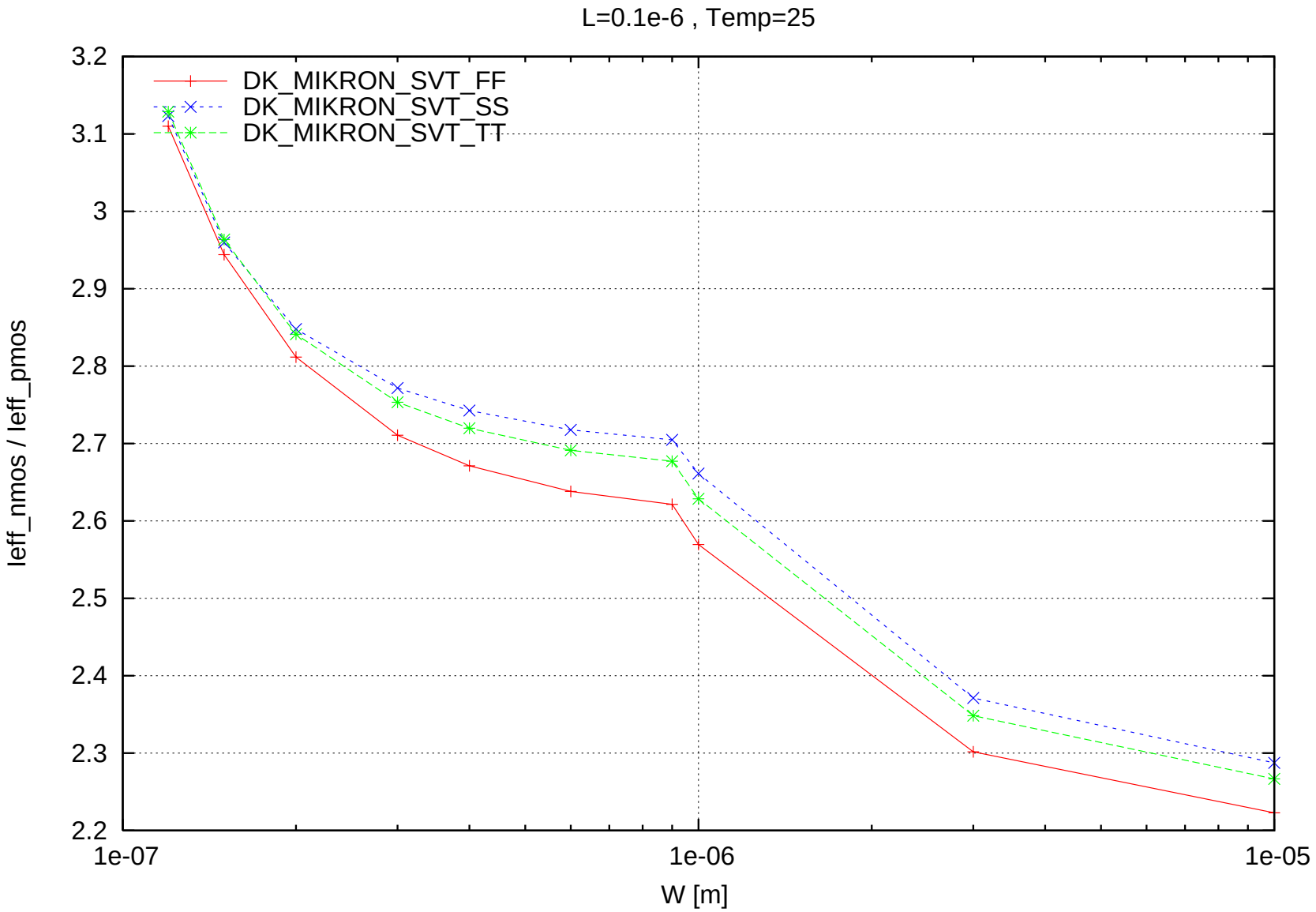


Crosscheck NMOS/PMOS (L=0.1e-6, Temp=25, po2act=0.63e-6, LPE=0)

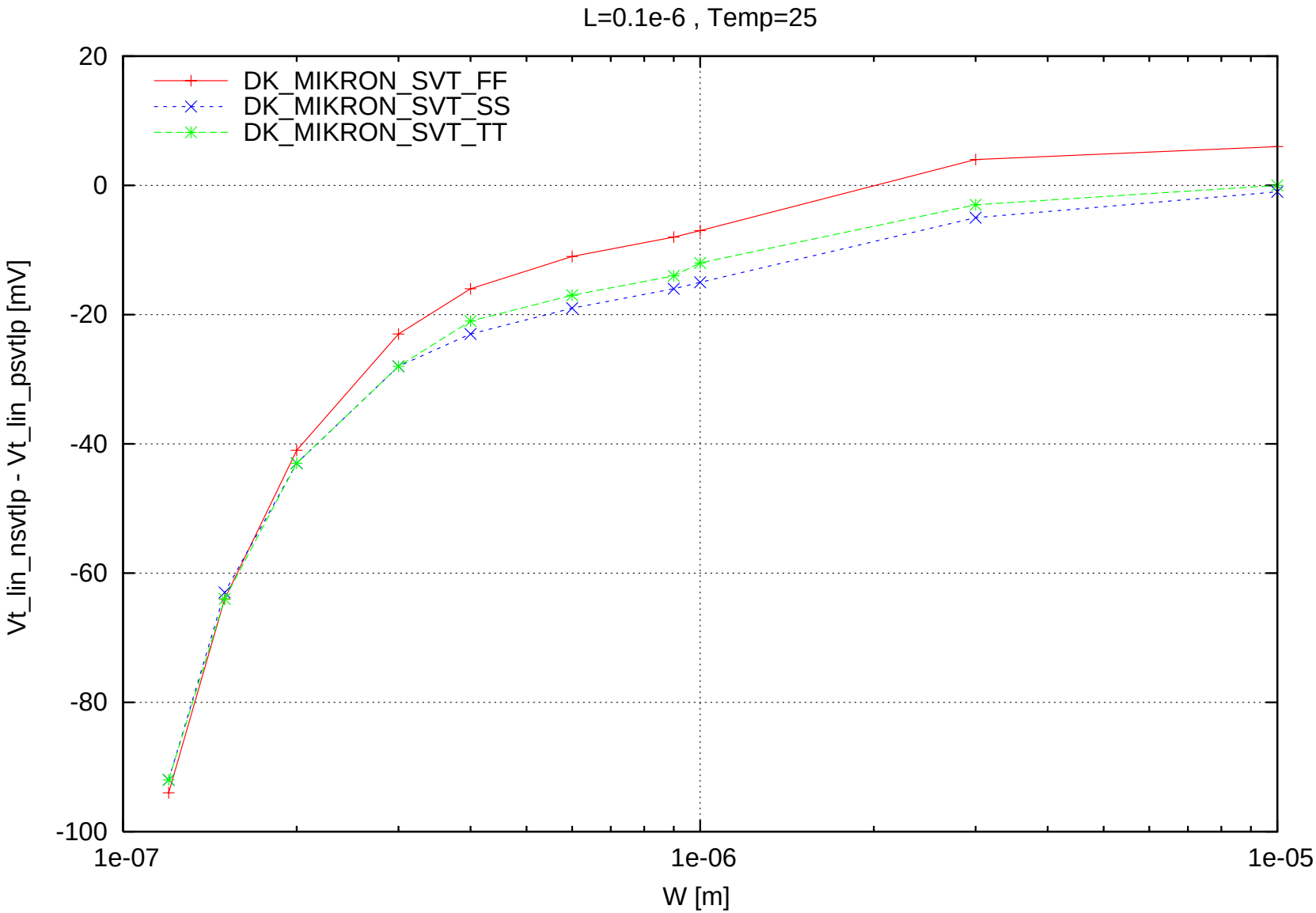
nsvt Isat_nmos / Isat_pmos vs. W [m] , L=0.1e-6 , Temp=25



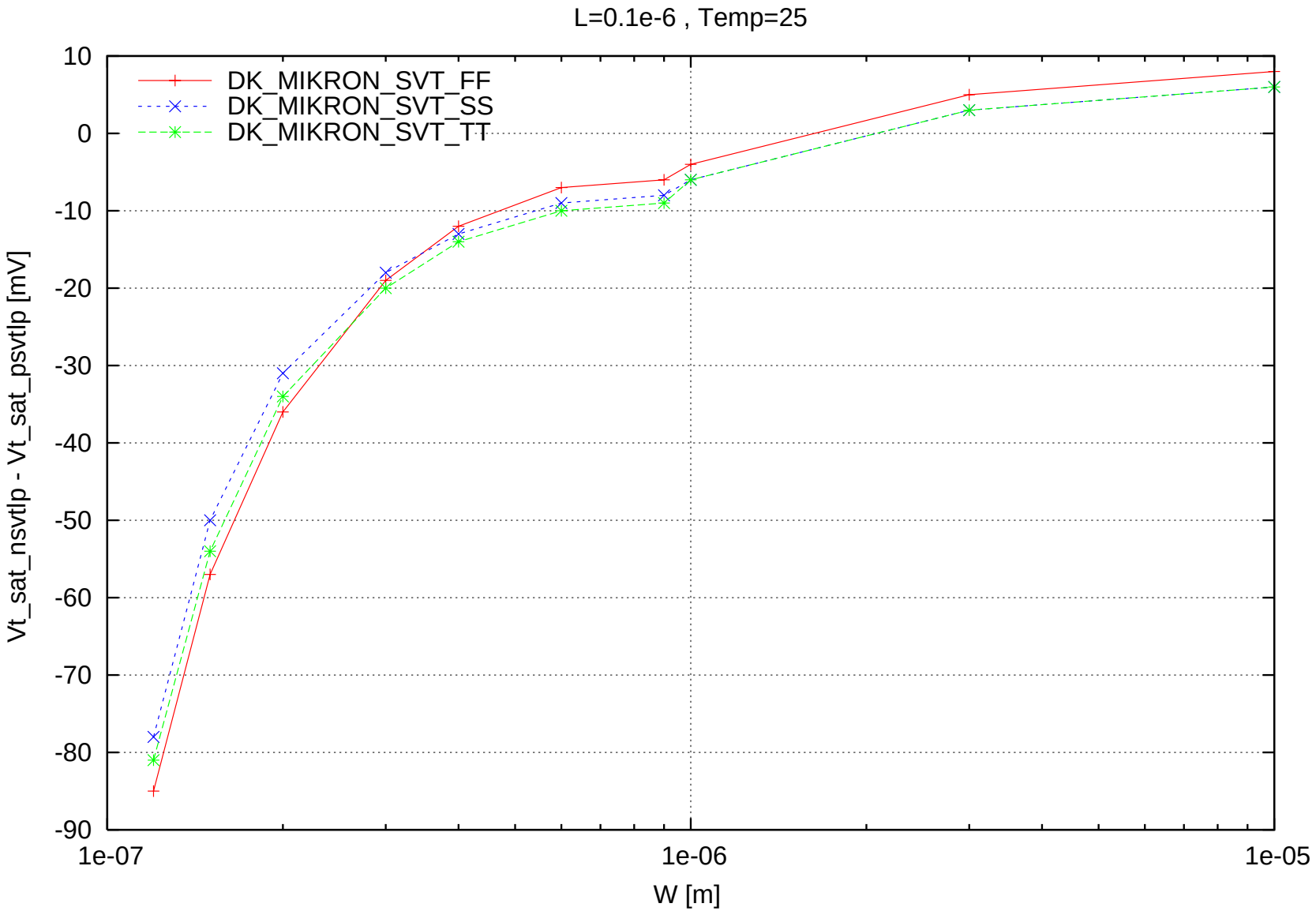
nsvt leff_nmos / leff_pmos vs. W [m] , L=0.1e-6 , Temp=25



nsvt Vt_lin_nsvtlp - Vt_lin_psvtlp [mV] vs. W [m] , L=0.1e-6 , Temp=25

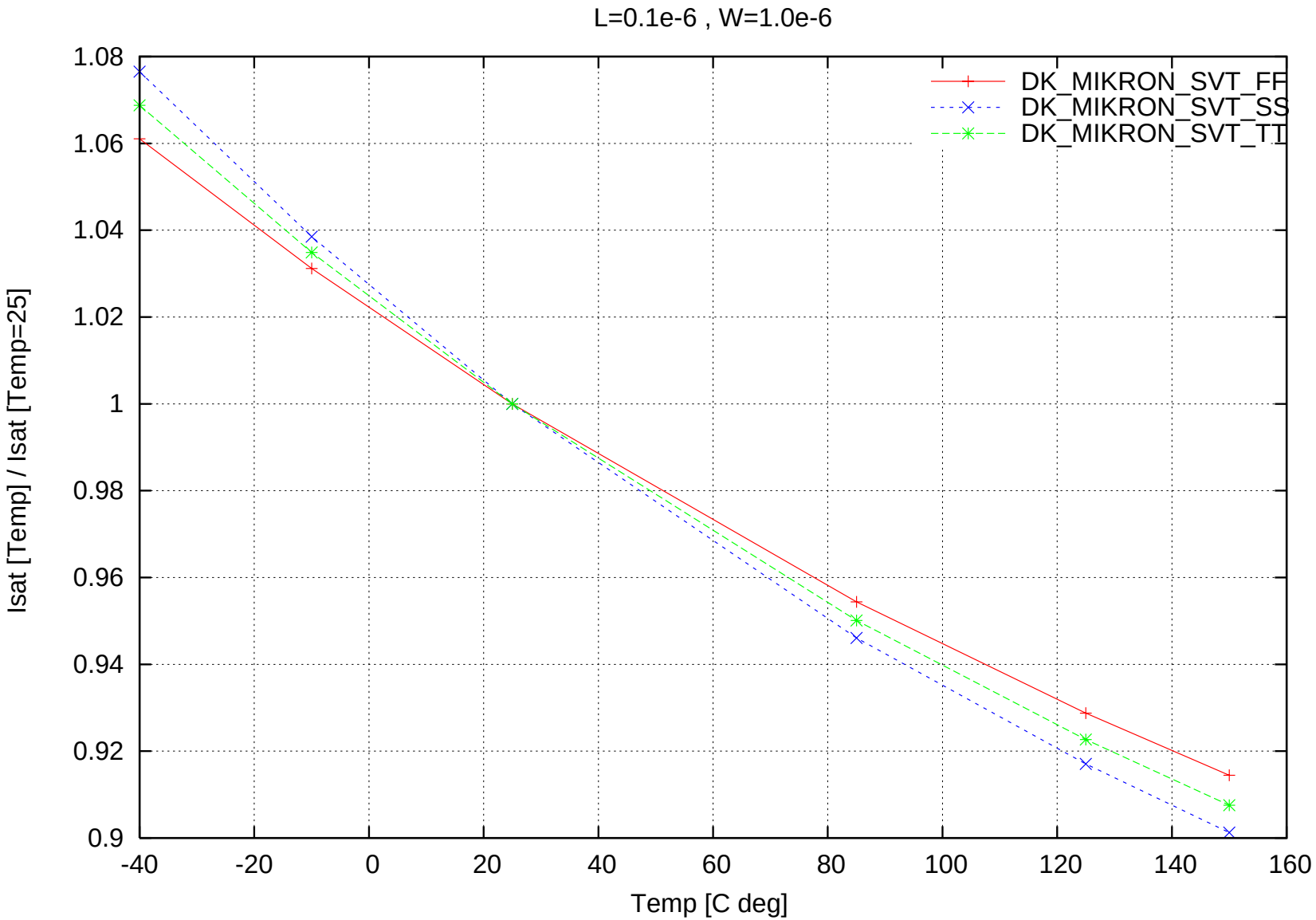


nsvt Vt_sat_nsvtlp - Vt_sat_psvtlp [mV] vs. W [m] , L=0.1e-6 , Temp=25

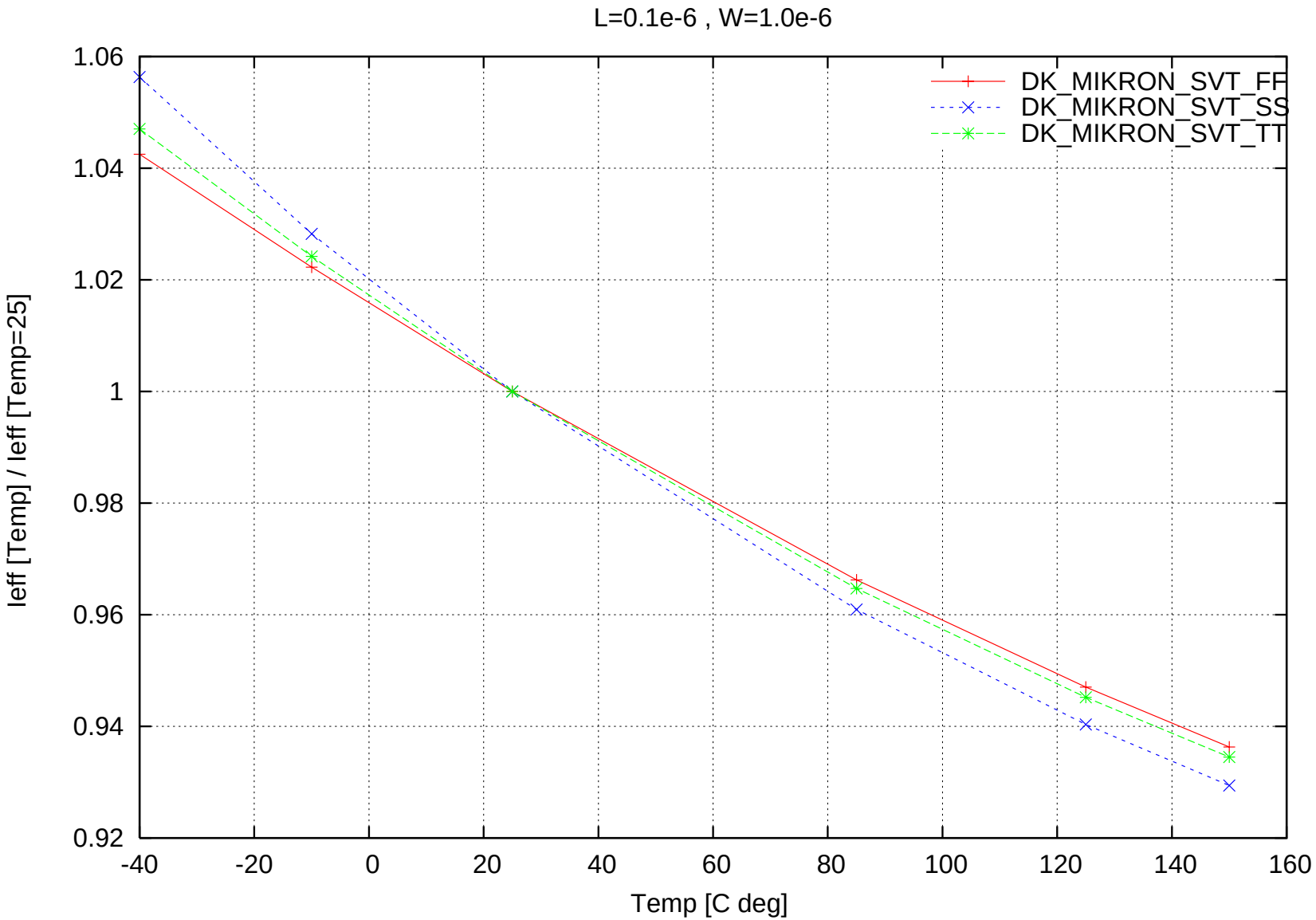


Scaling versus Temp for NMOS (L=0.1e-6, W=1.0e-6, po2act=0.63e-6, LPE=0)

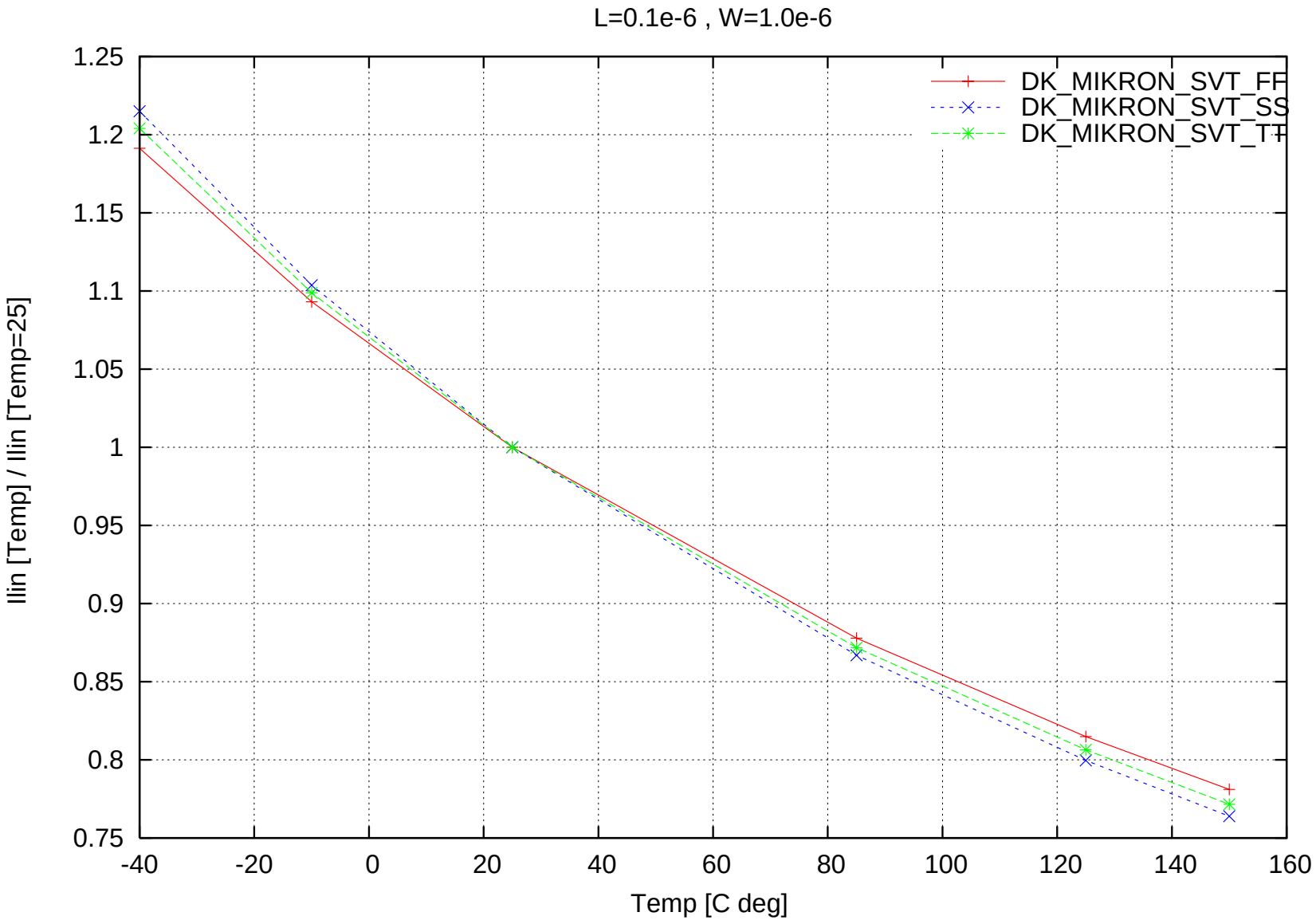
nsvt Isat [Temp] / Isat [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



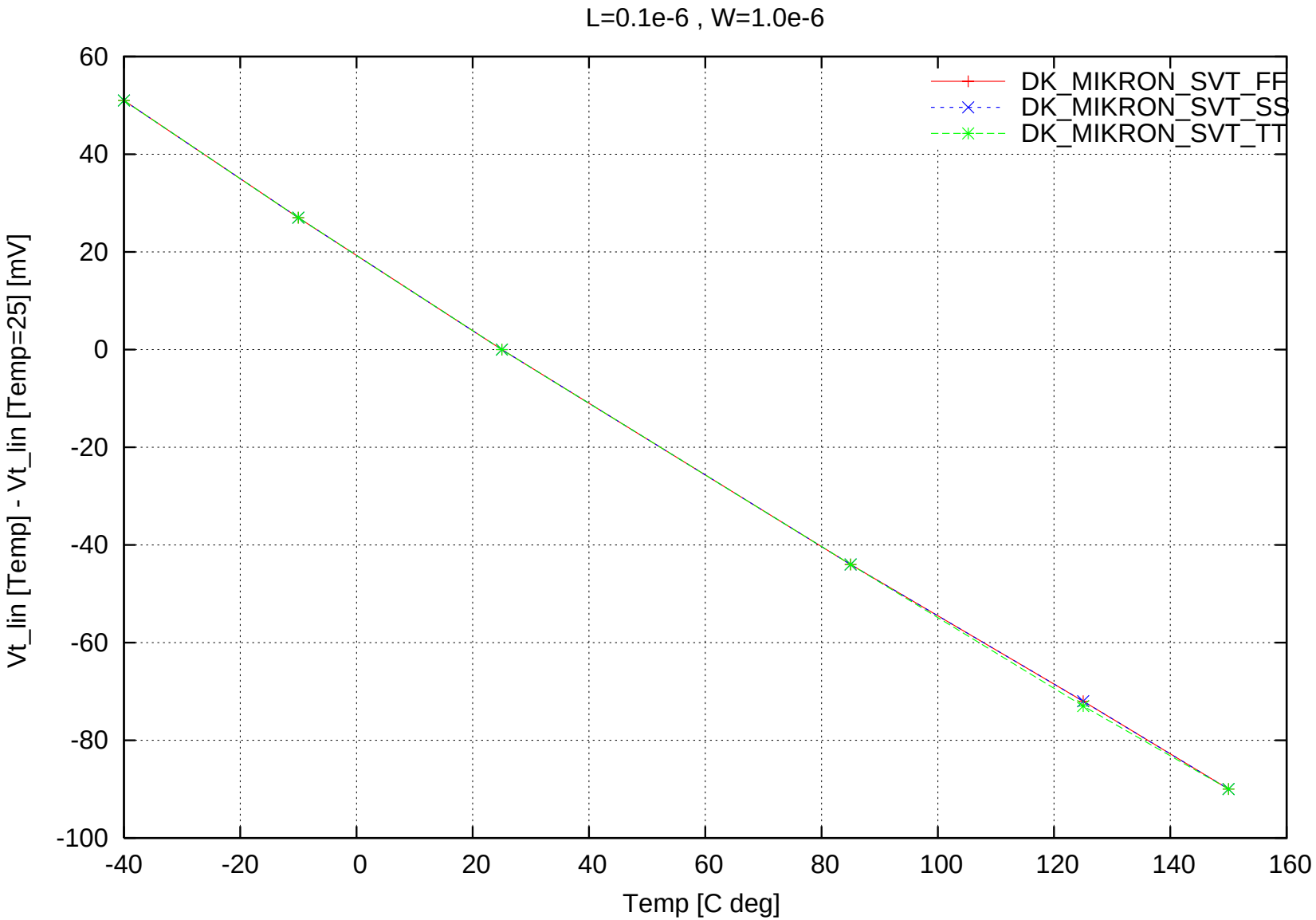
nsvt Ieff [Temp] / Ieff [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



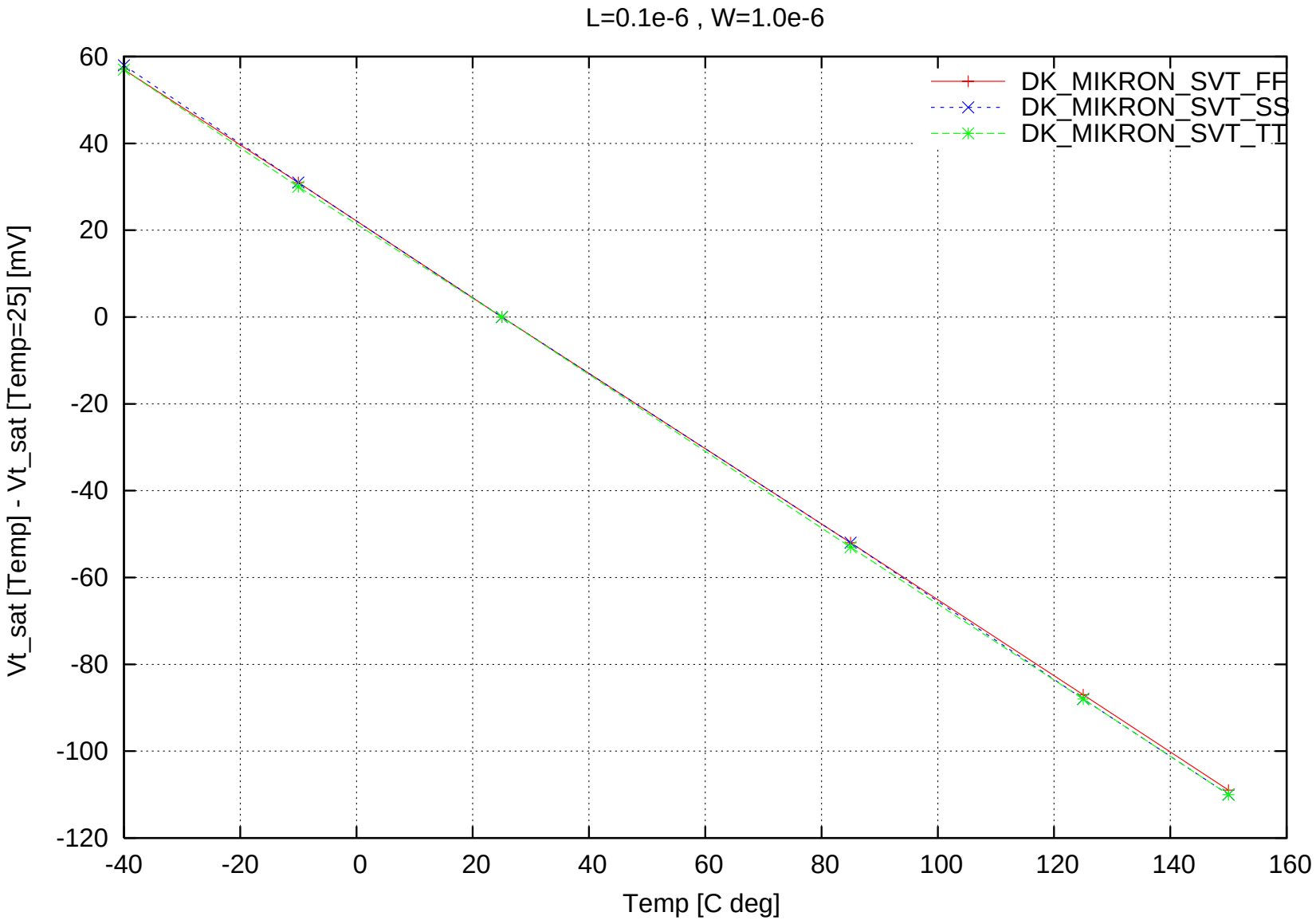
nsvt Ilin [Temp] / Ilin [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



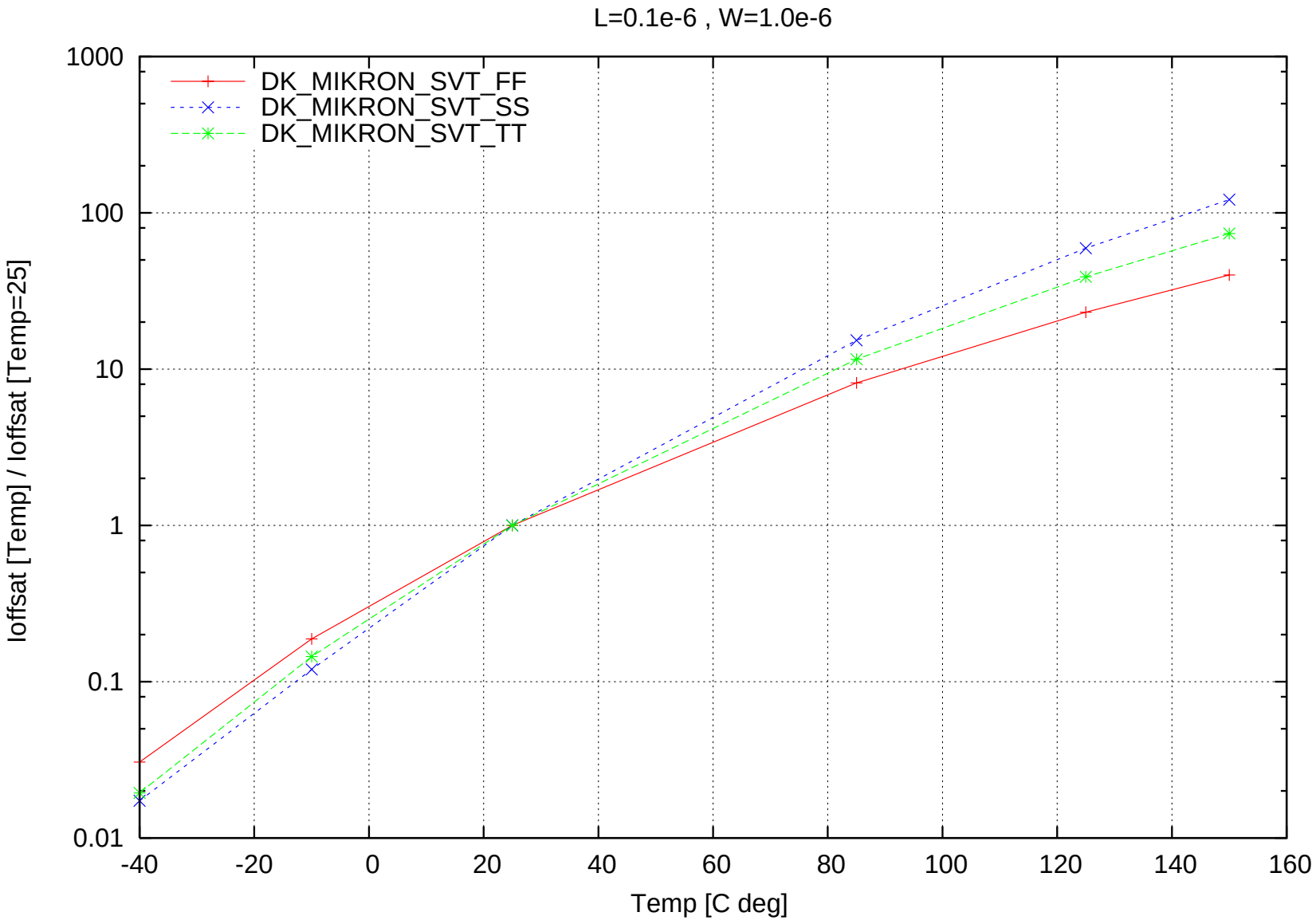
nsvt Vt_lin [Temp] - Vt_lin [Temp=25] [mV] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



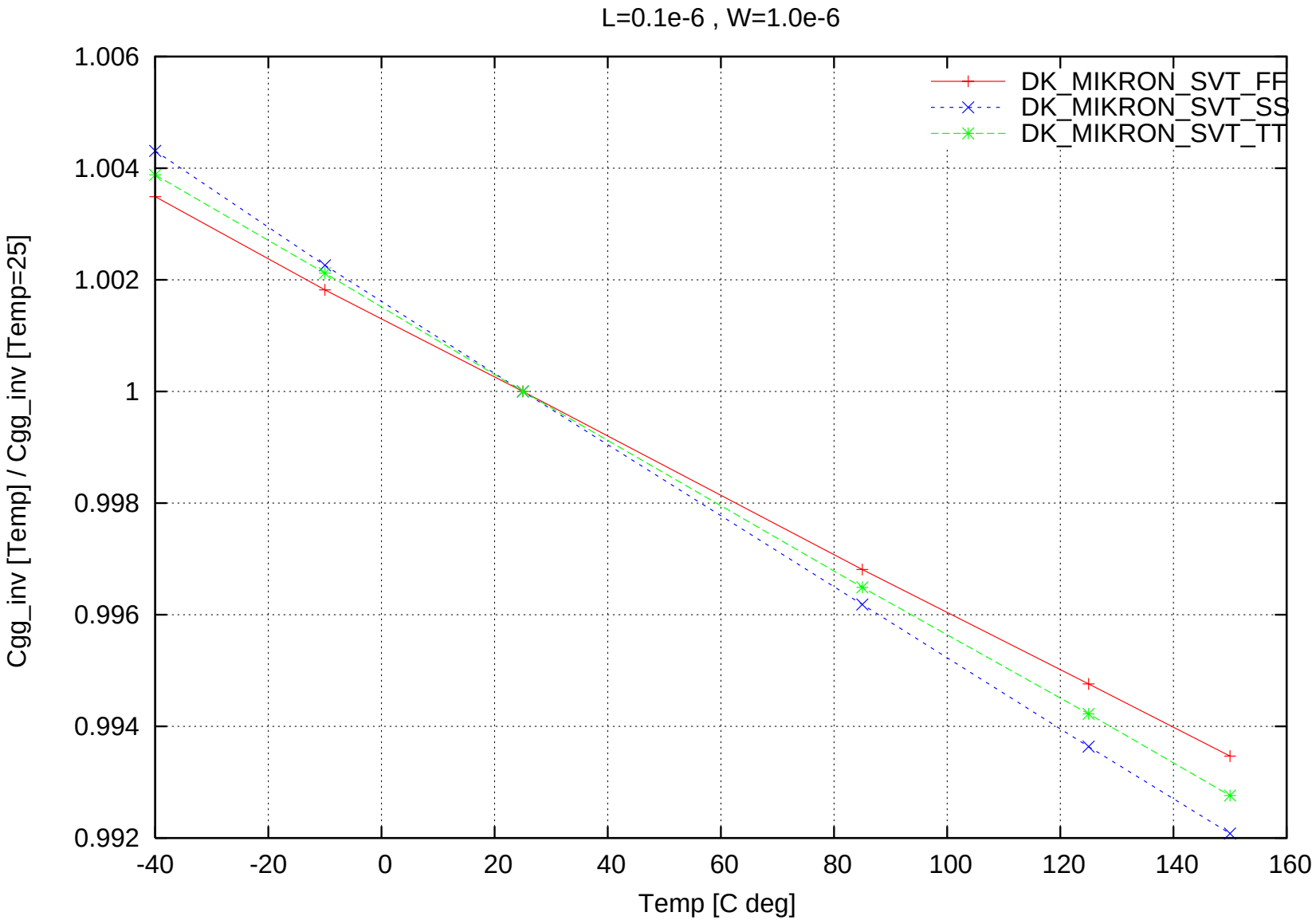
nsvt Vt_sat [Temp] - Vt_sat [Temp=25] [mV] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



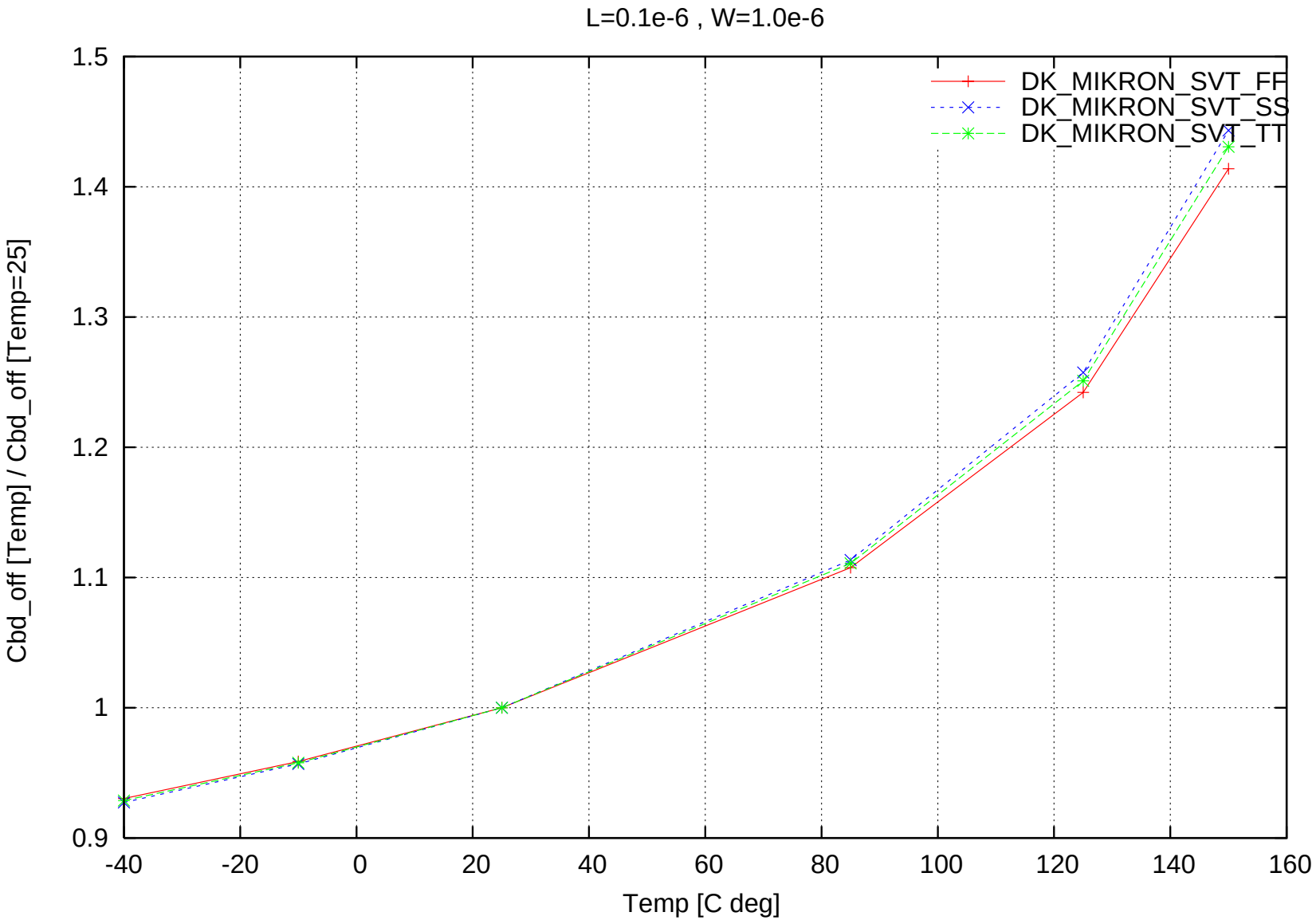
nsvt Ioffsat [Temp] / Ioffsat [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



nsvt Cgg_inv [Temp] / Cgg_inv [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



nsvt Cbd_off [Temp] / Cbd_off [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6

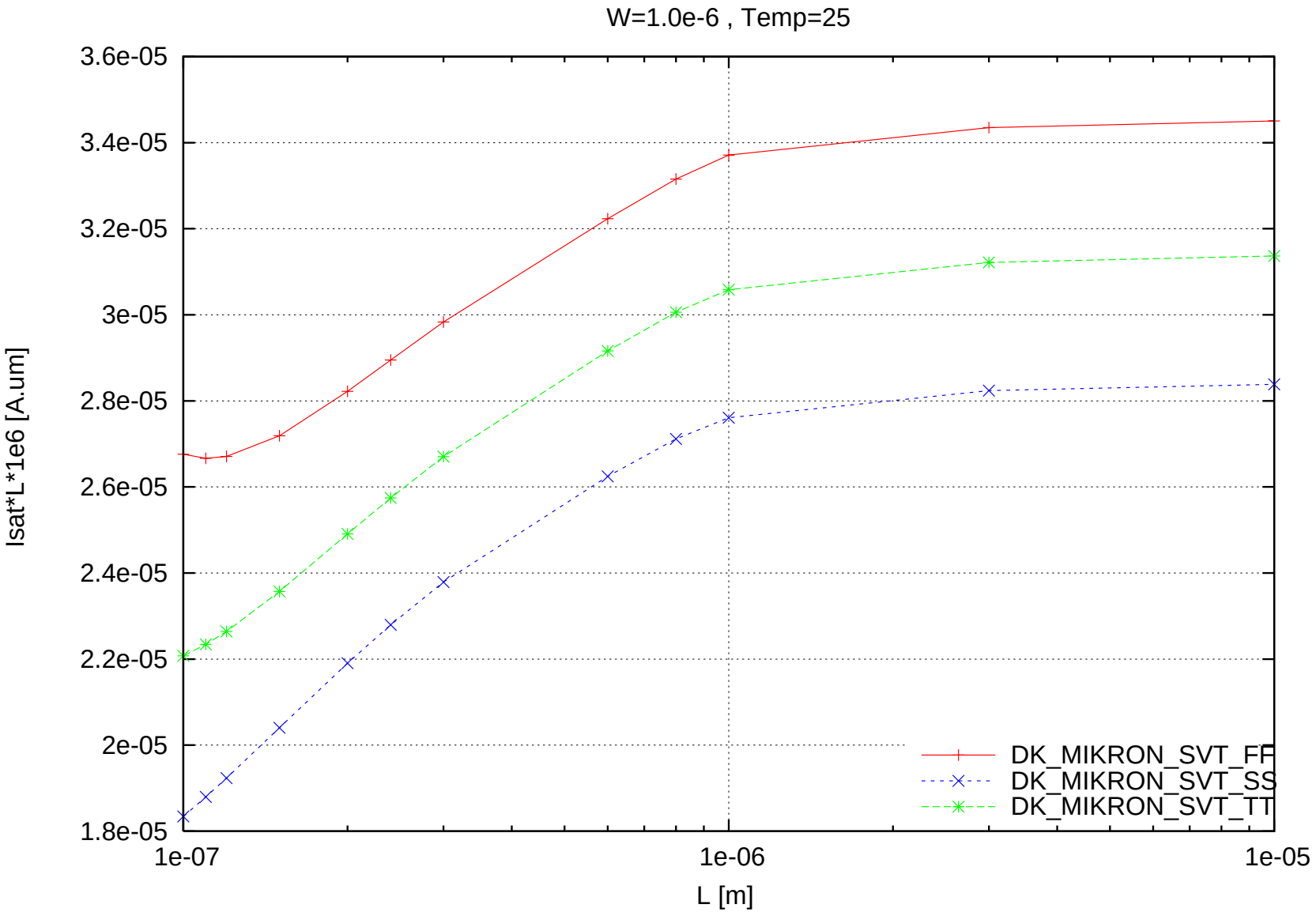


PSVT

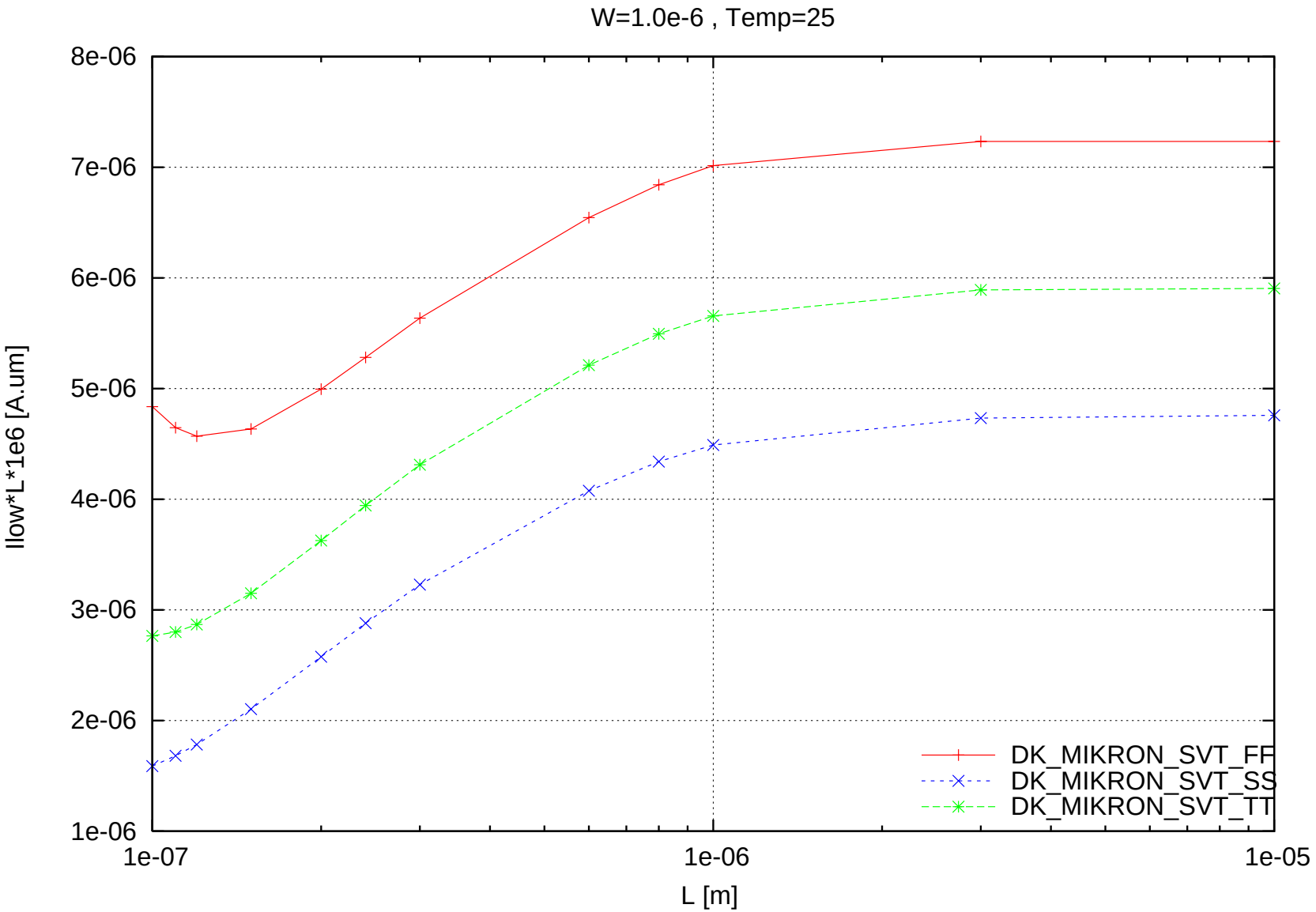
Electrical characteristics scaling

Scaling versus Length for PMOS (W=1.0e-6, Temp=25, po2act=0.63e-6, LPE=0)

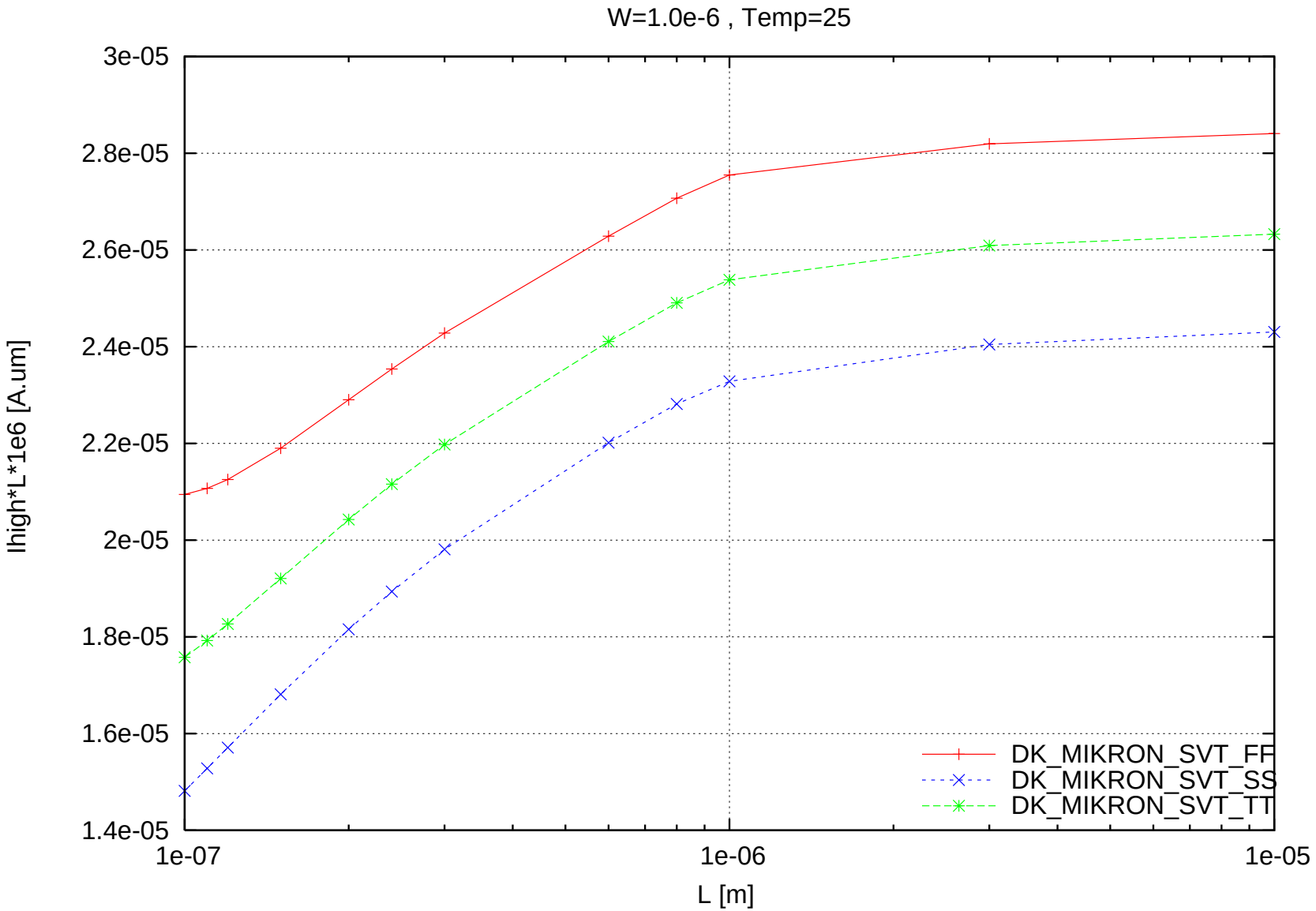
psvt Isat*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



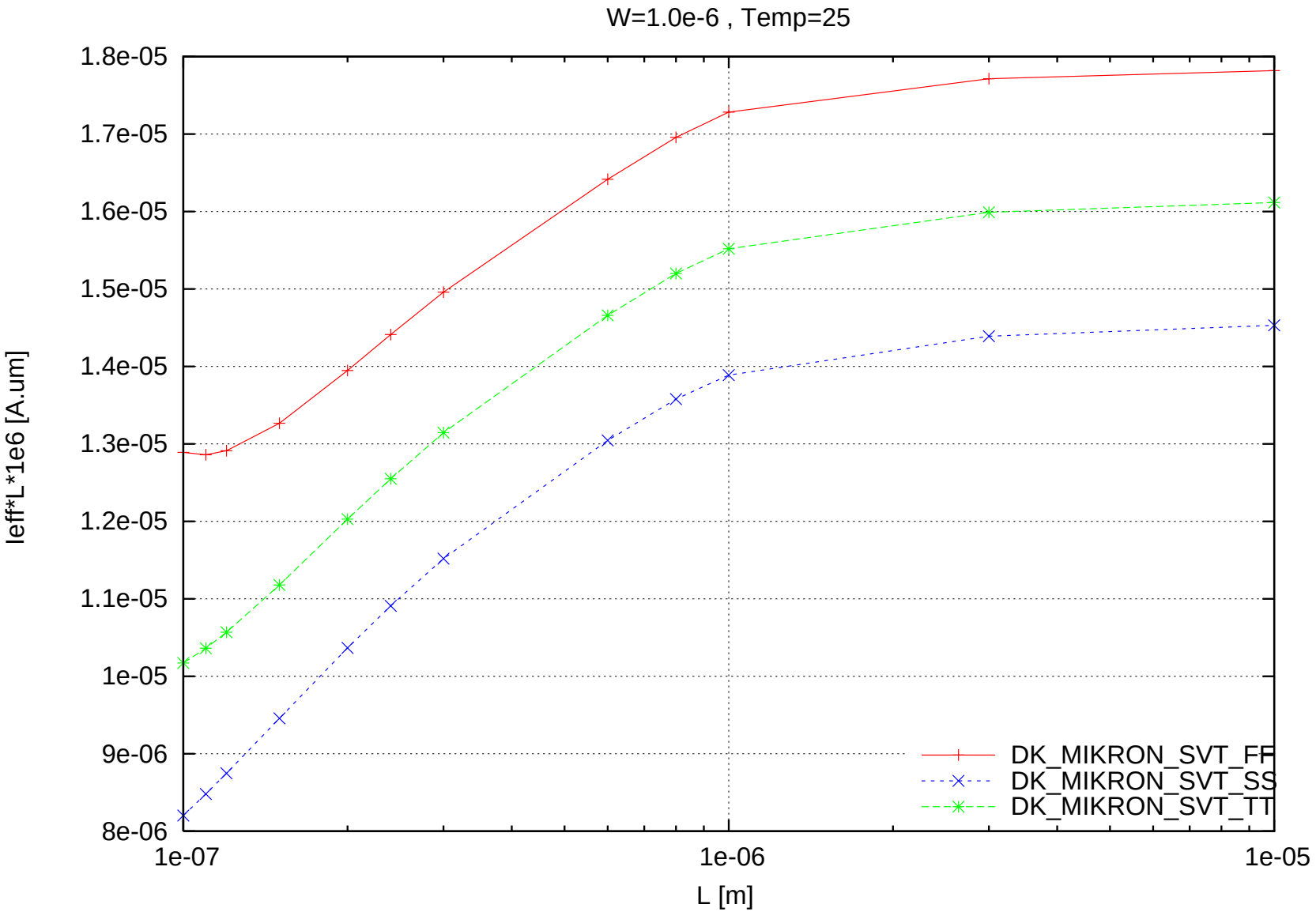
psvt Ilow*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



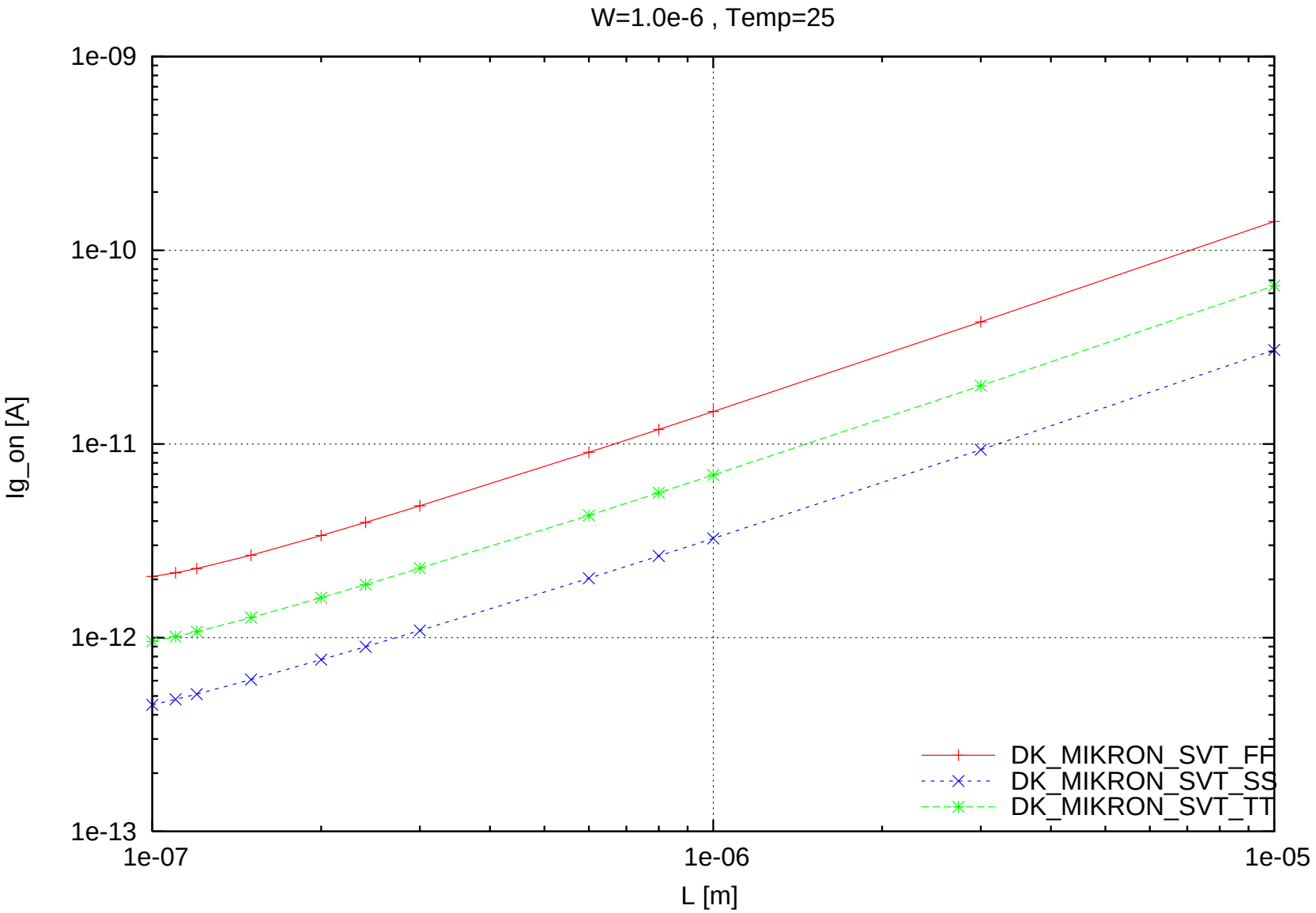
psvt Ihigh*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



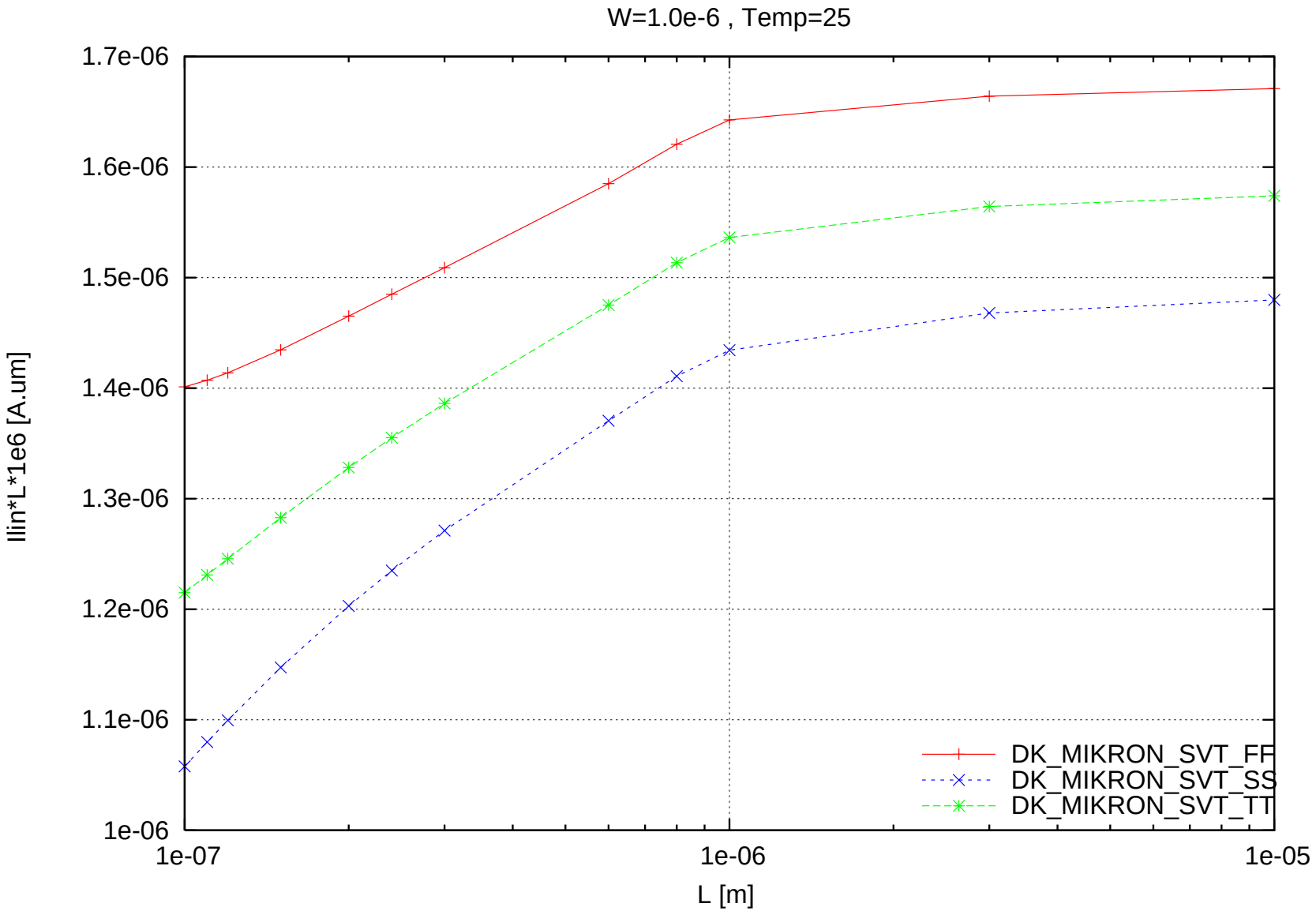
psvt Ieff*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



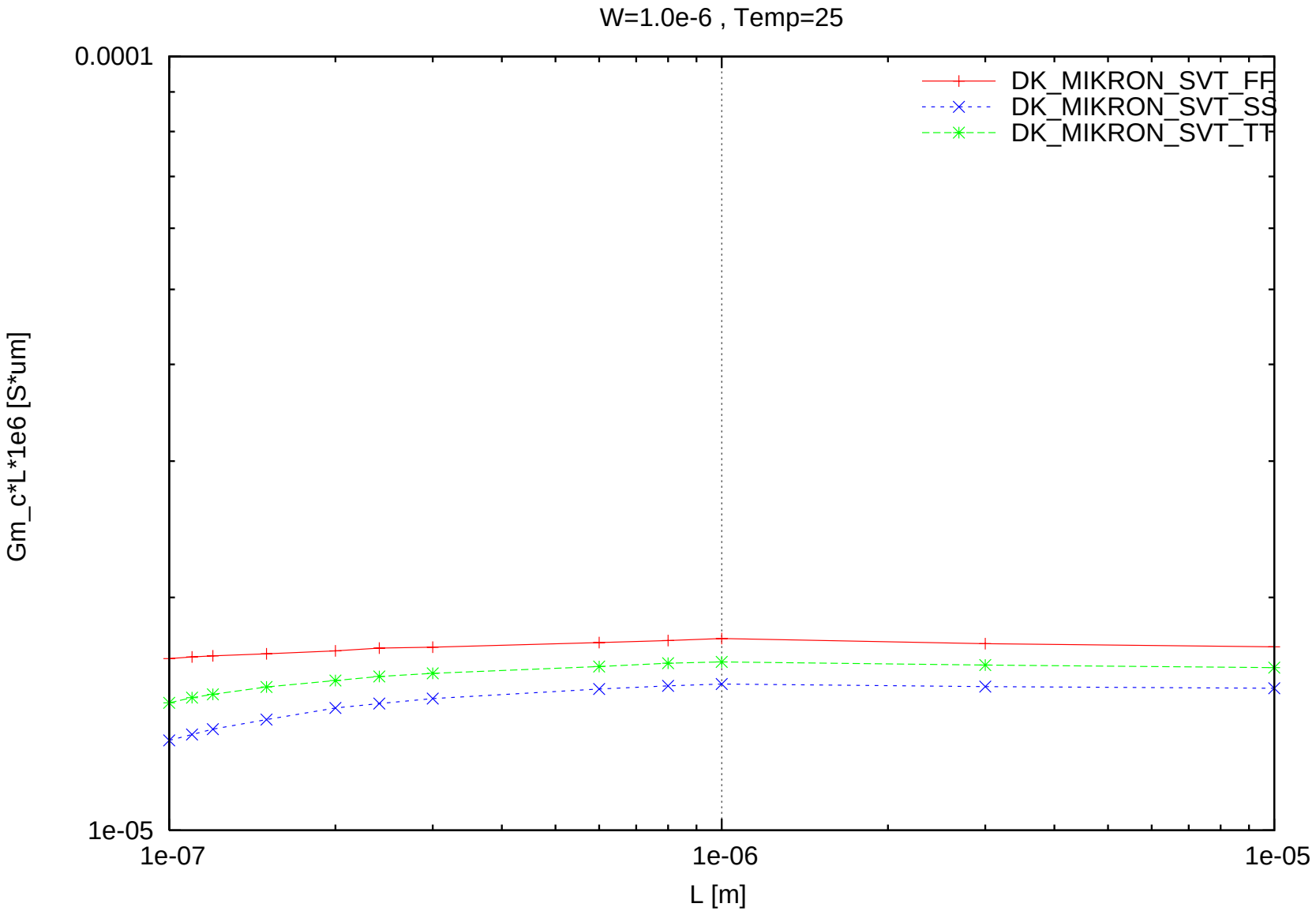
psvt Ig_on [A] vs. L [m] , W=1.0e-6 , Temp=25



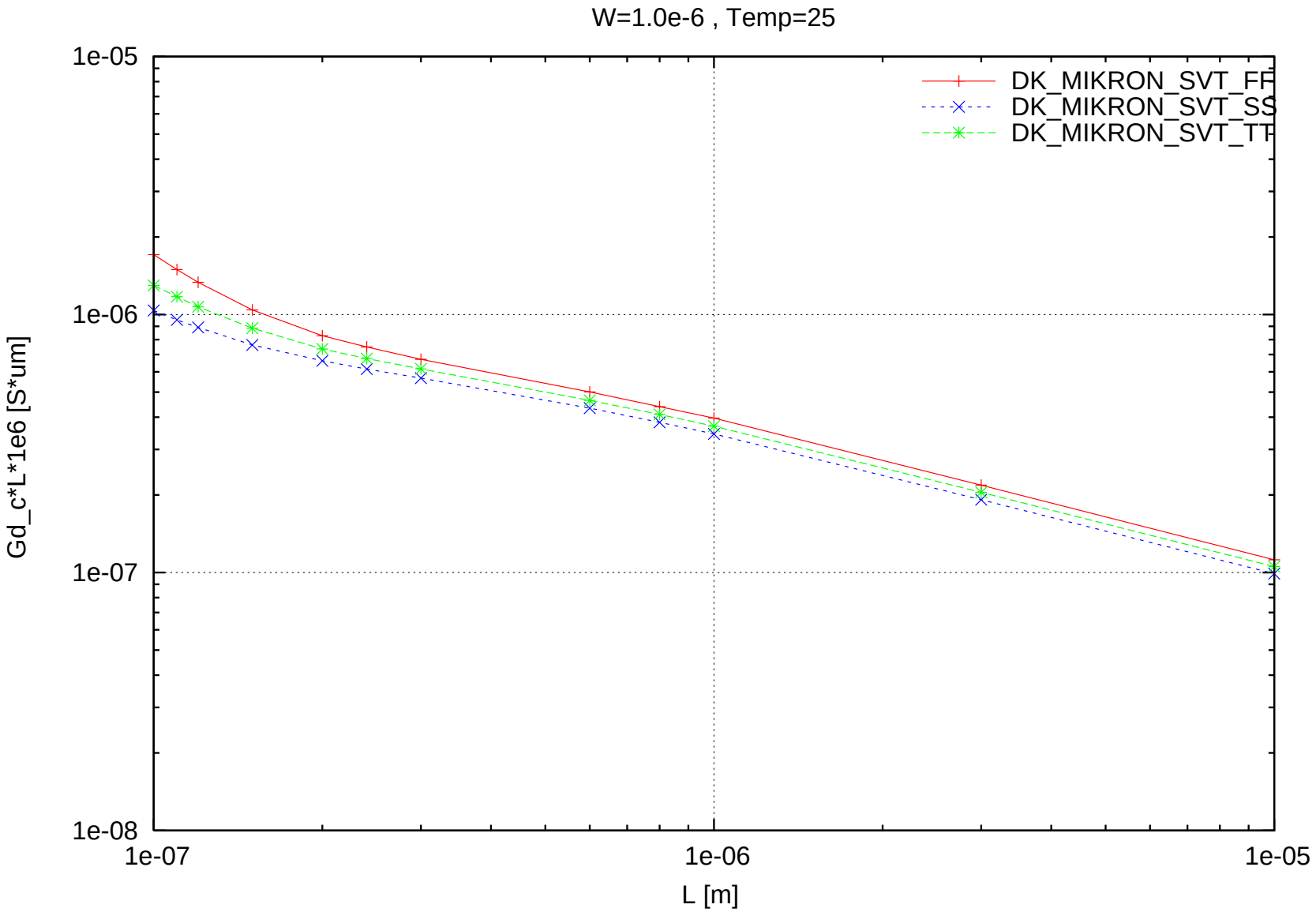
psvt Ilin*L*1e6 [A.um] vs. L [m] , W=1.0e-6 , Temp=25



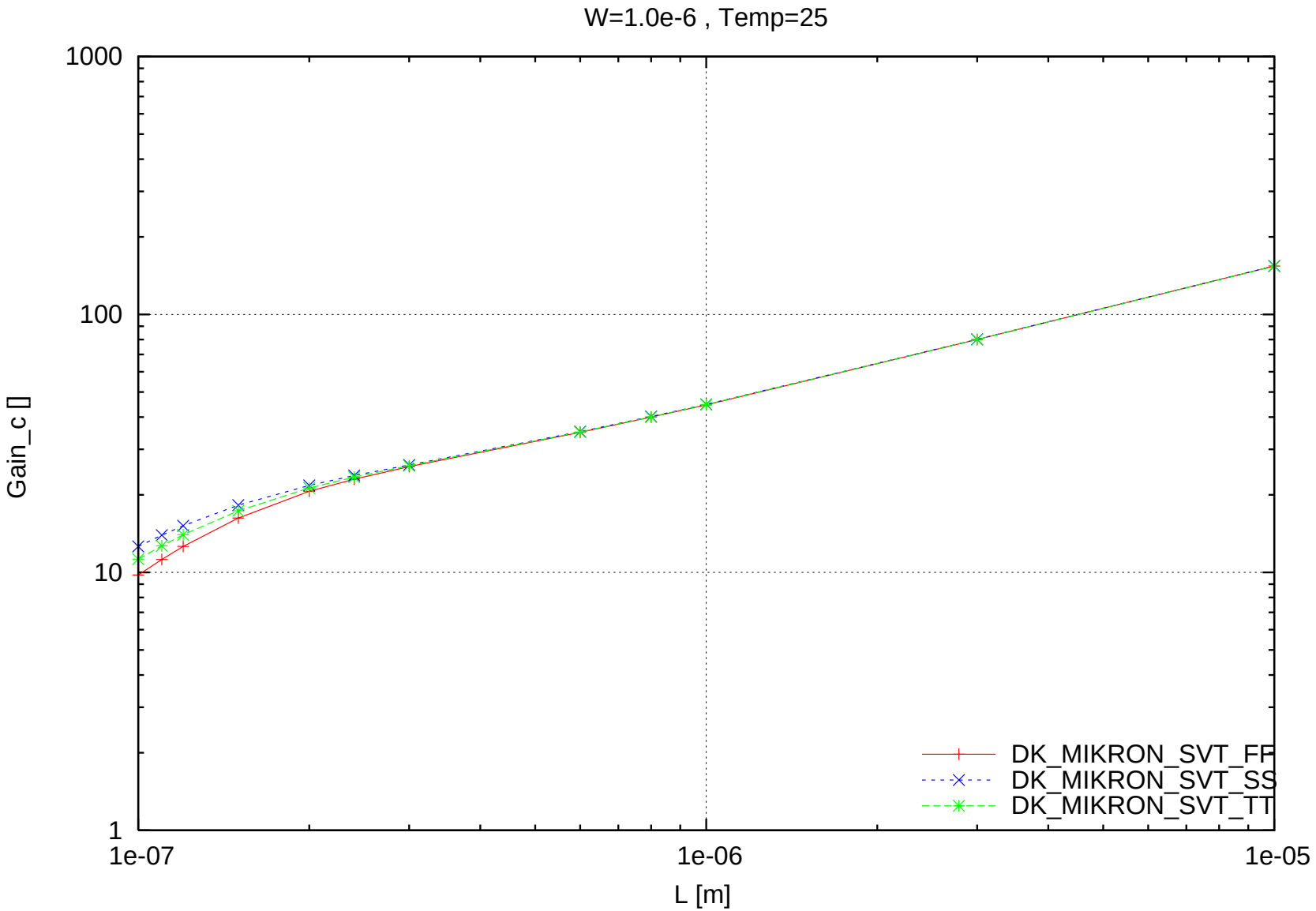
psvt Gm_c*L*1e6 [S*um] vs. L [m] , W=1.0e-6 , Temp=25



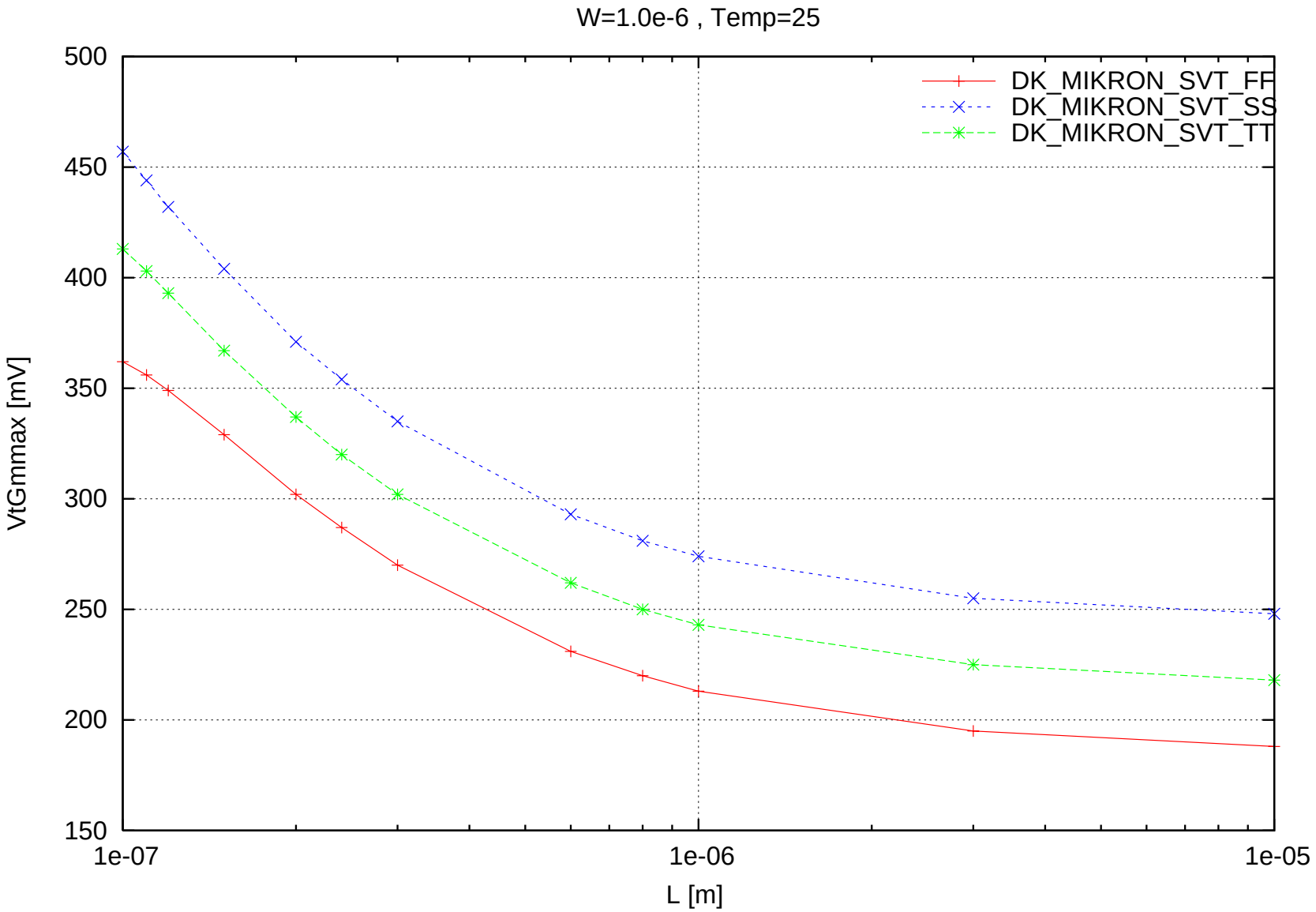
psvt Gd_c*L*1e6 [S*um] vs. L [m] , W=1.0e-6 , Temp=25



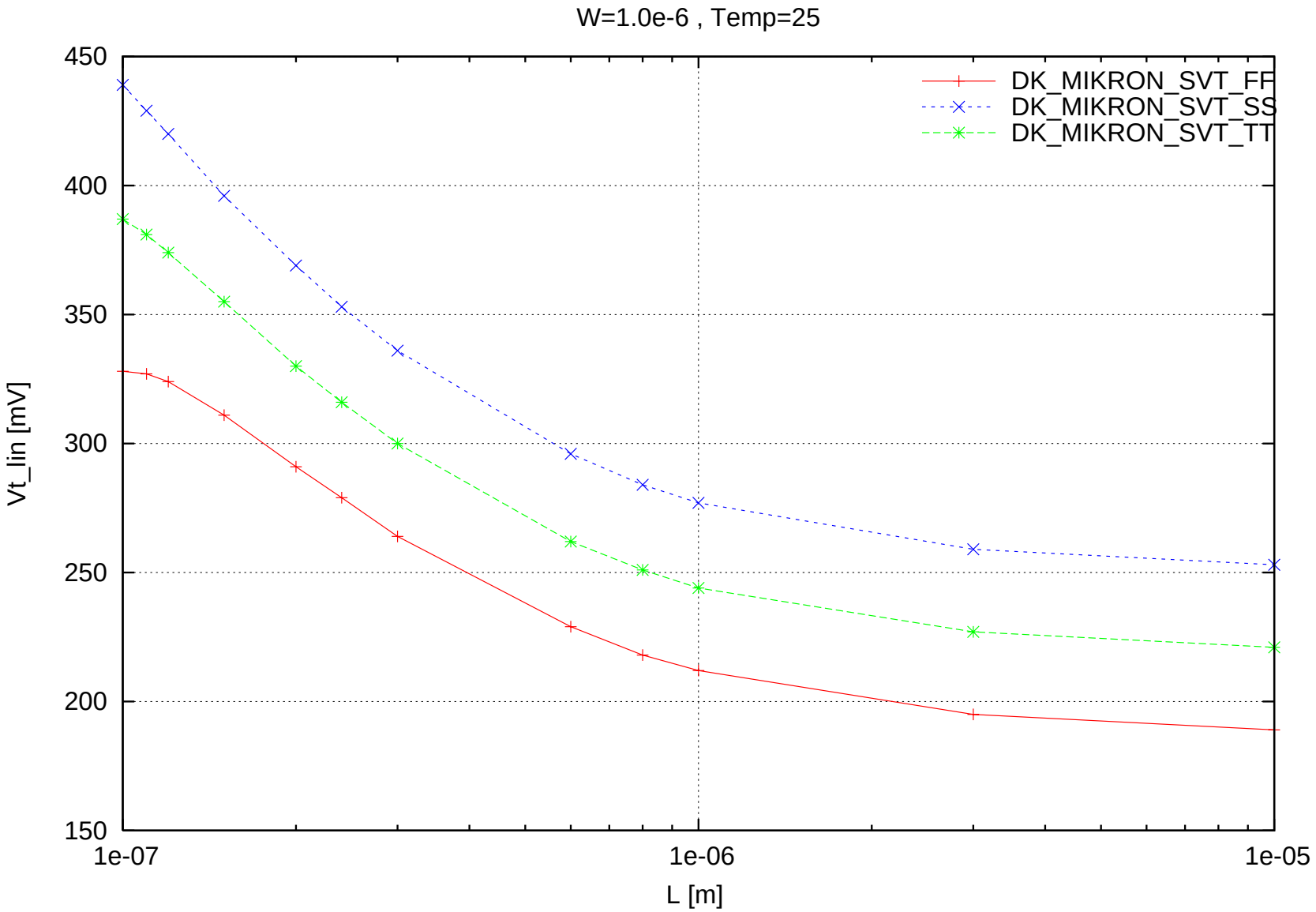
psvt Gain_c [] vs. L [m] , W=1.0e-6 , Temp=25



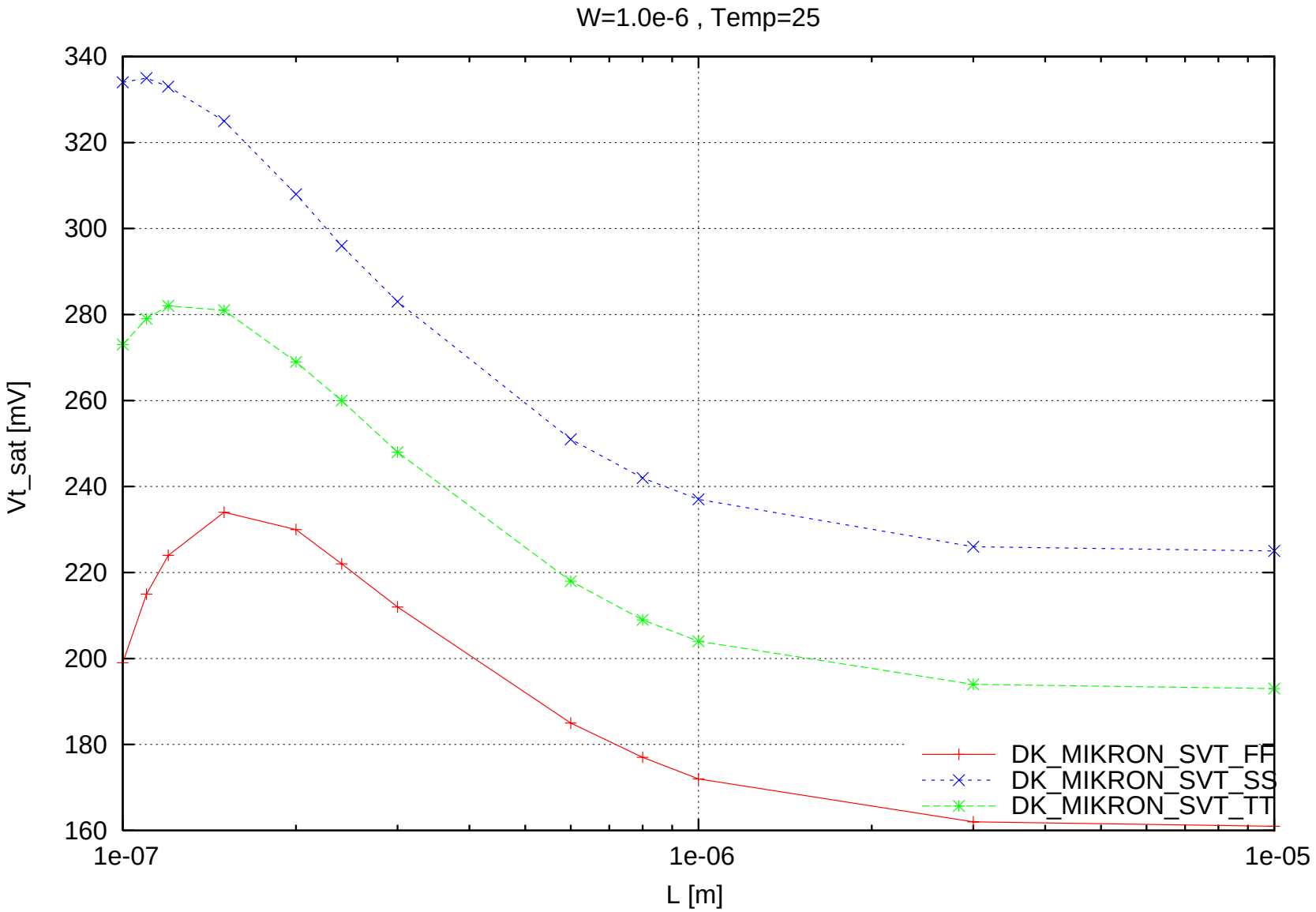
psvt VtGmmax [mV] vs. L [m] , W=1.0e-6 , Temp=25



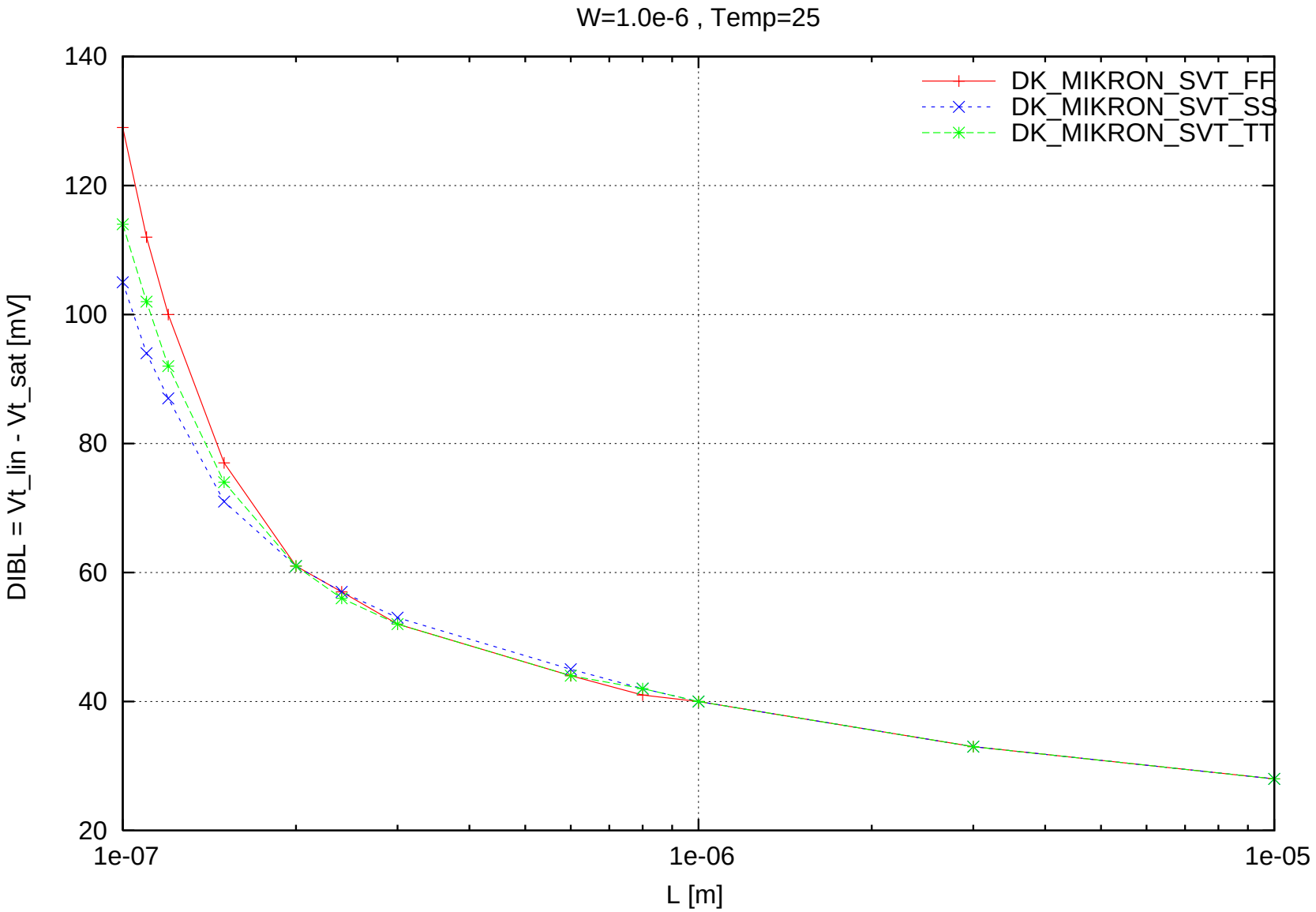
psvt Vt_lin [mV] vs. L [m] , W=1.0e-6 , Temp=25



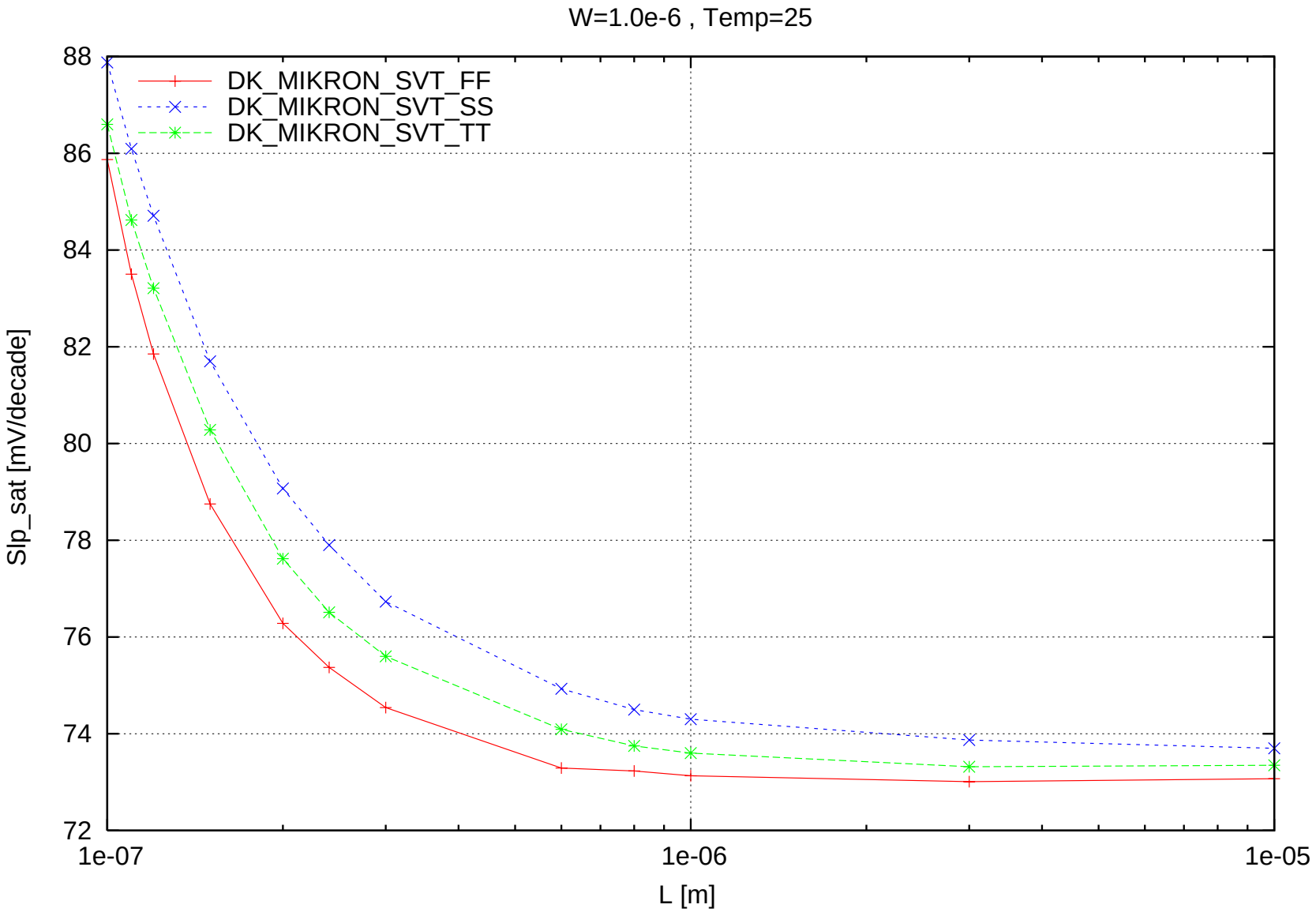
psvt Vt_sat [mV] vs. L [m] , W=1.0e-6 , Temp=25



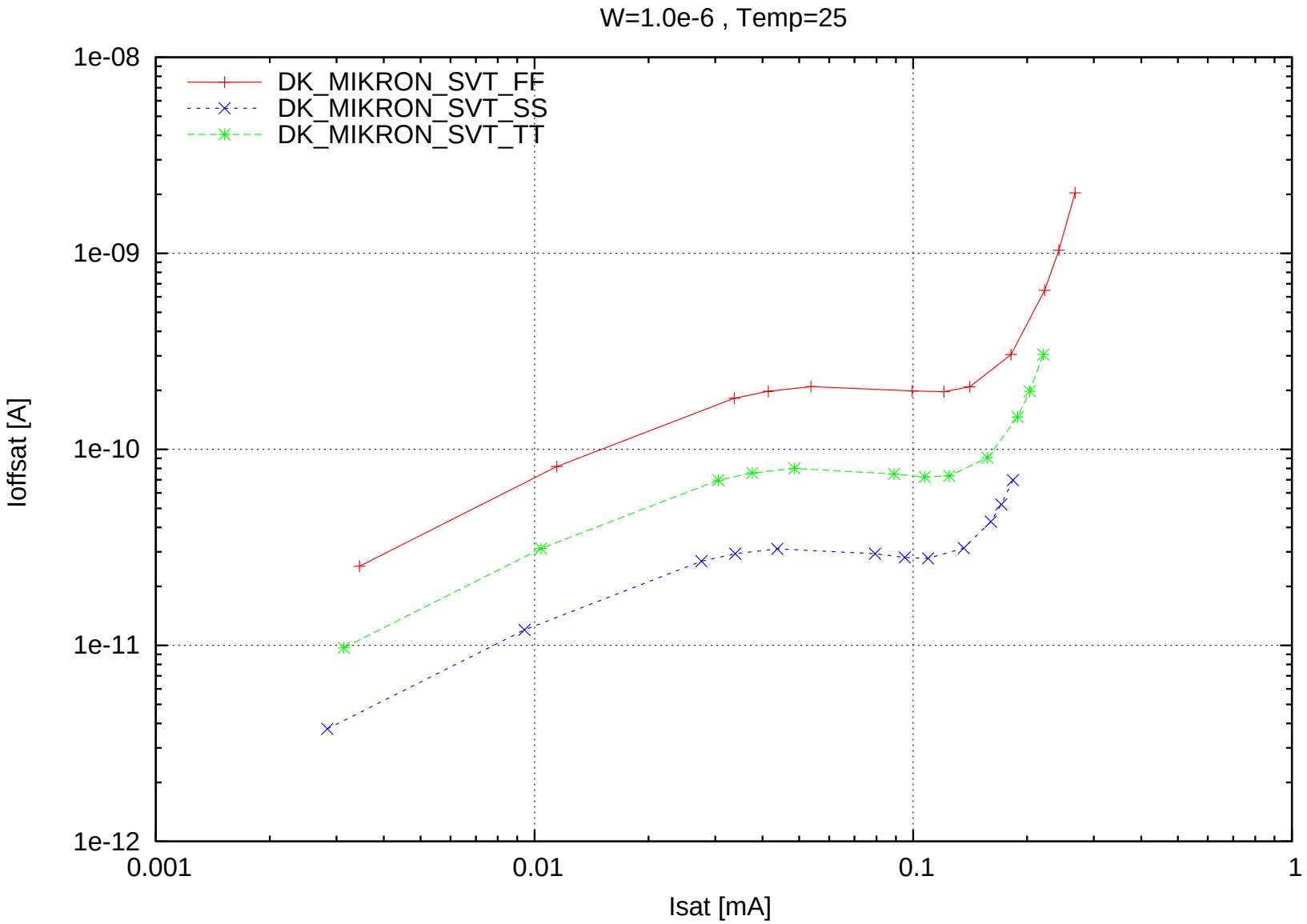
psvt DIBL = Vt_lin - Vt_sat [mV] vs. L [m] , W=1.0e-6 , Temp=25



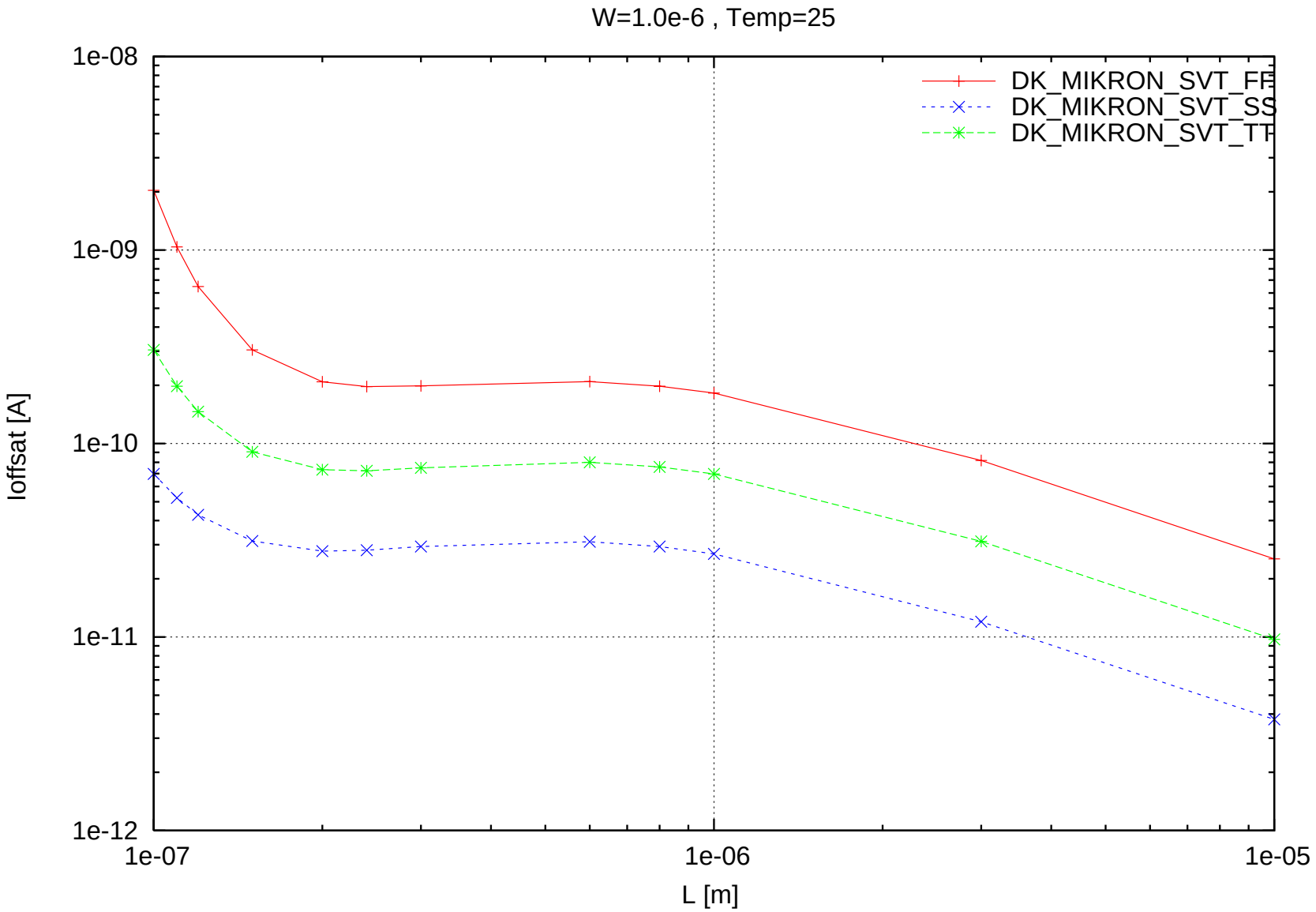
psvt Slp_sat [mV/decade] vs. L [m] , W=1.0e-6 , Temp=25



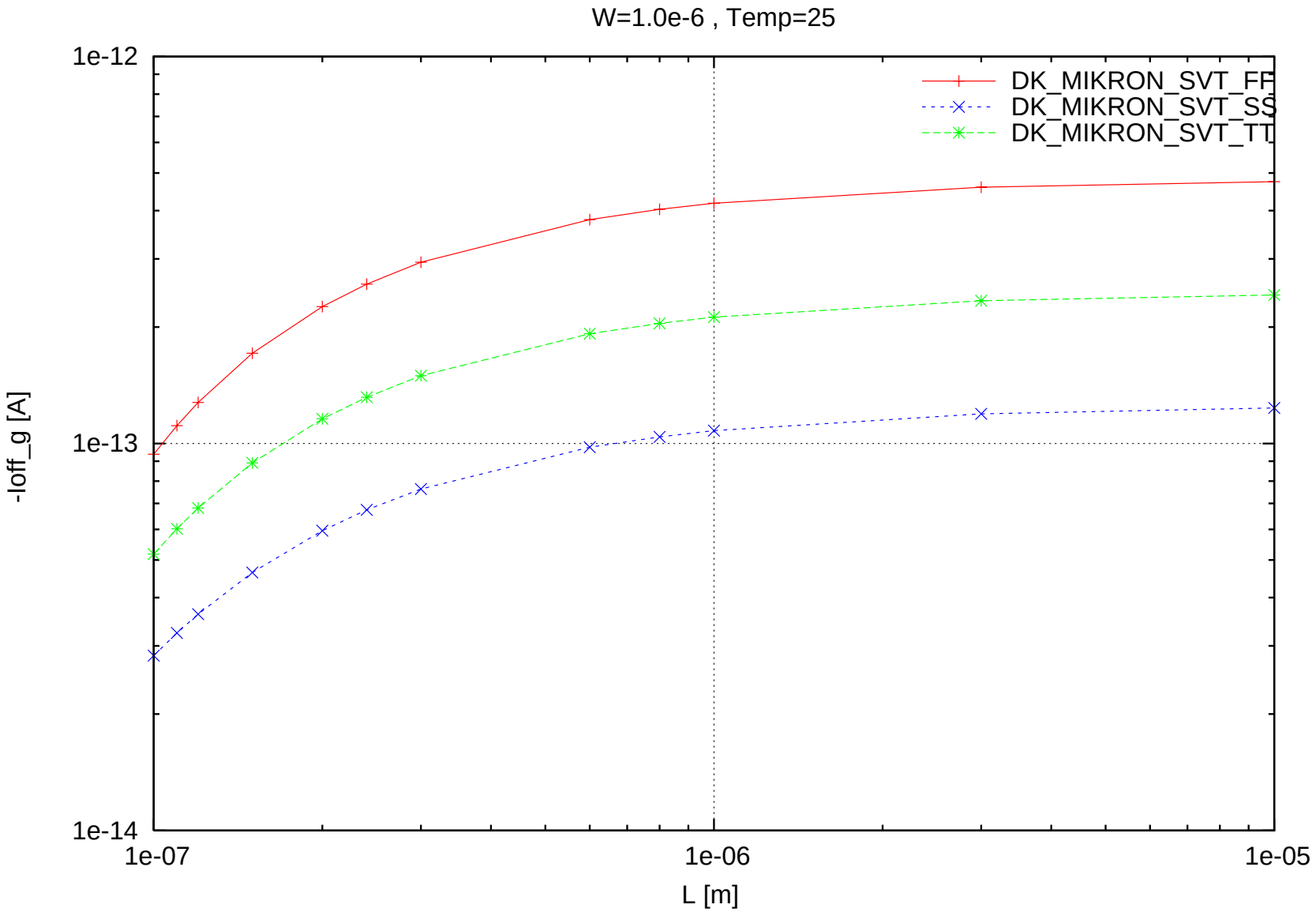
psvt Ioffsat [A] vs. Isat [mA] , W=1.0e-6 , Temp=25



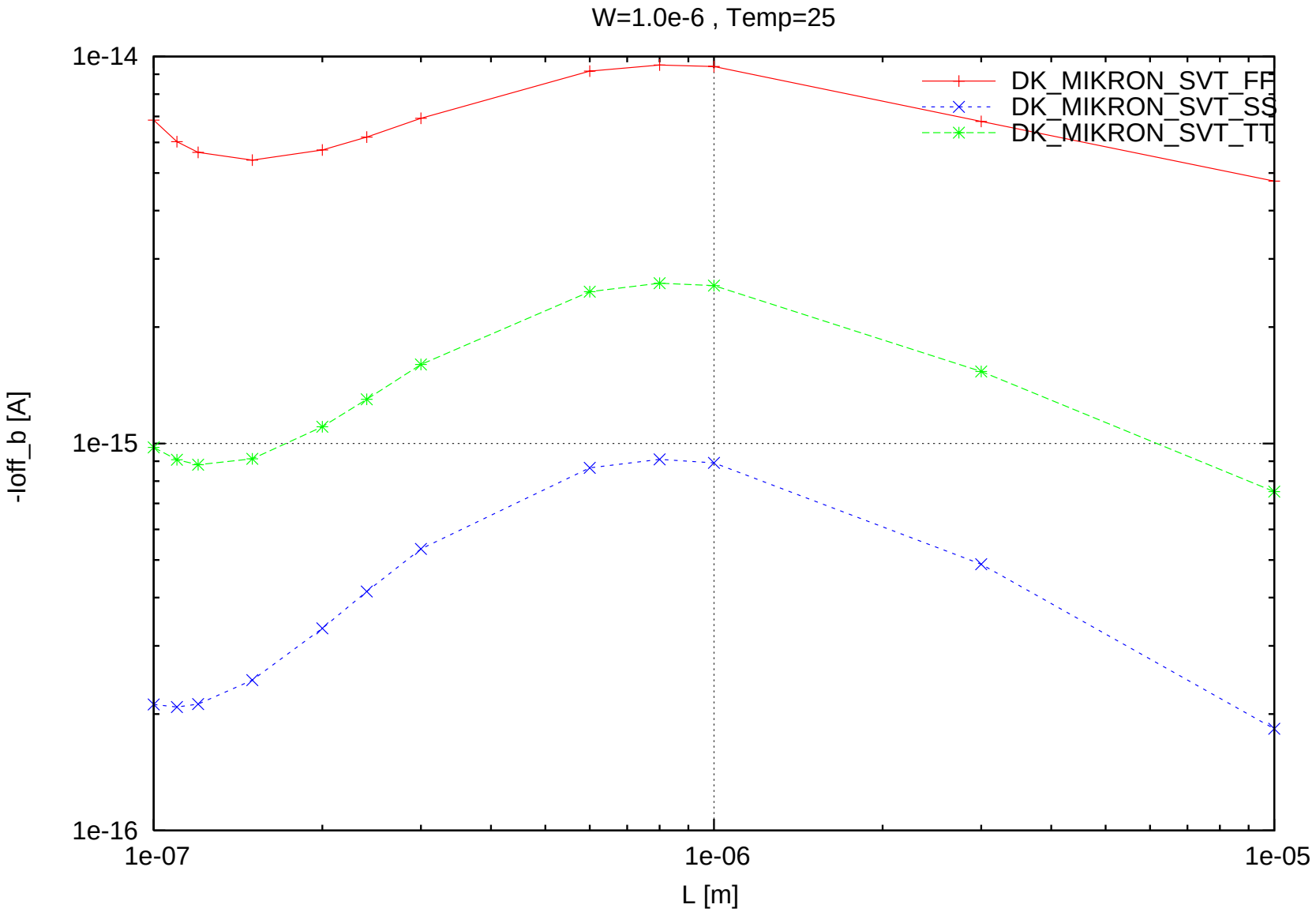
psvt Ioffsat [A] vs. L [m] , W=1.0e-6 , Temp=25



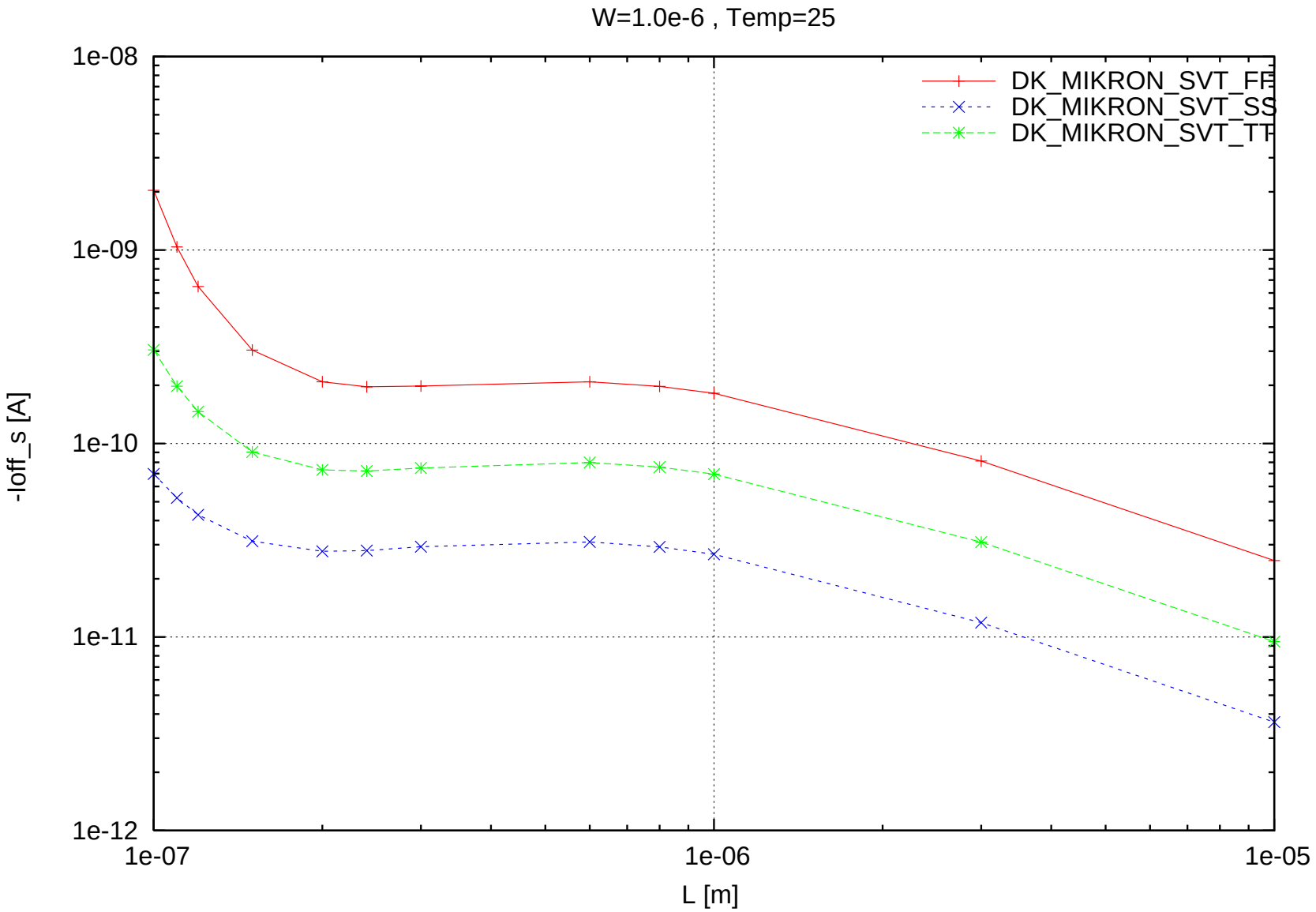
psvt -Ioff_g [A] vs. L [m] , W=1.0e-6 , Temp=25



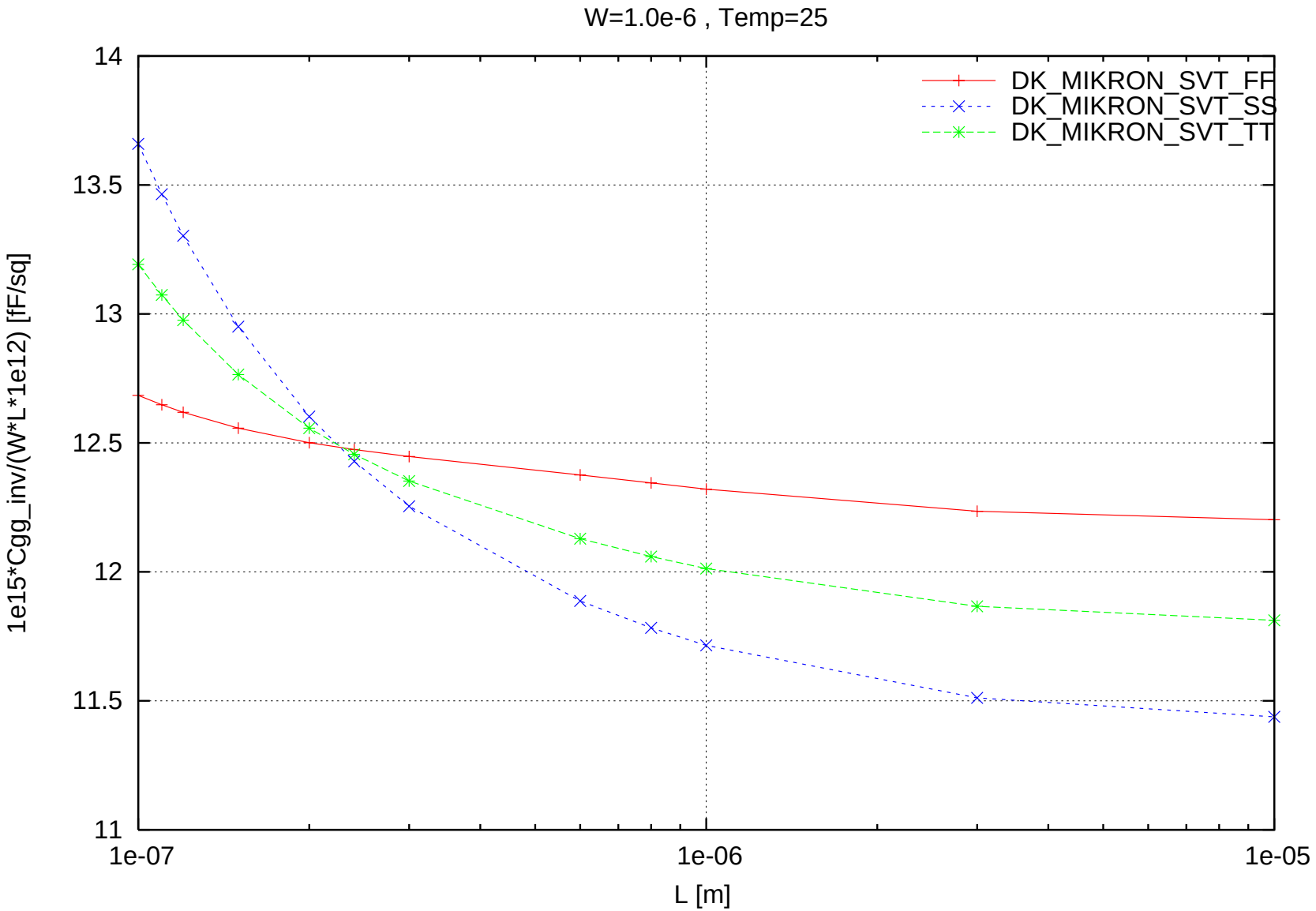
psvt -Ioff_b [A] vs. L [m] , W=1.0e-6 , Temp=25



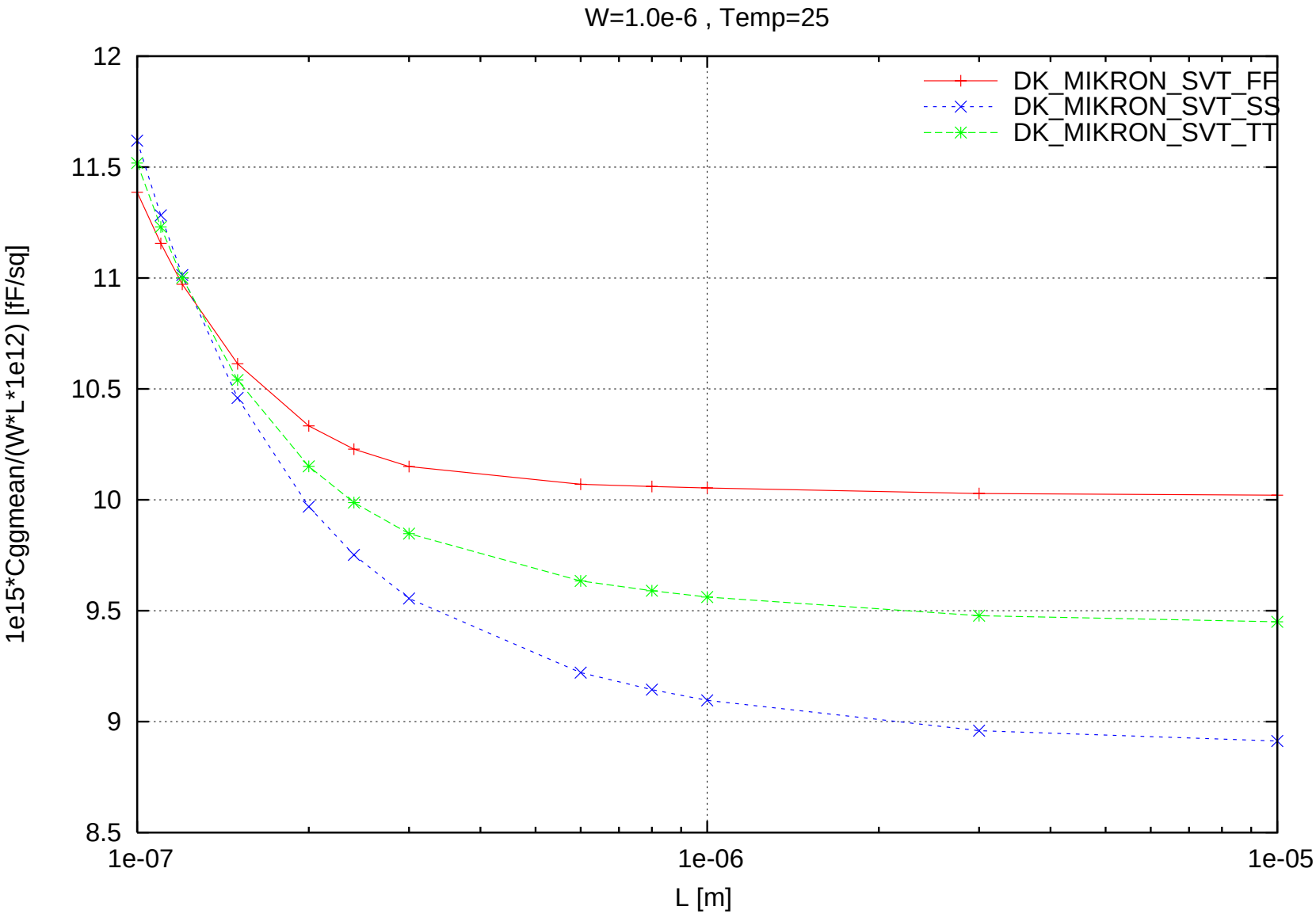
psvt -Ioff_s [A] vs. L [m] , W=1.0e-6 , Temp=25



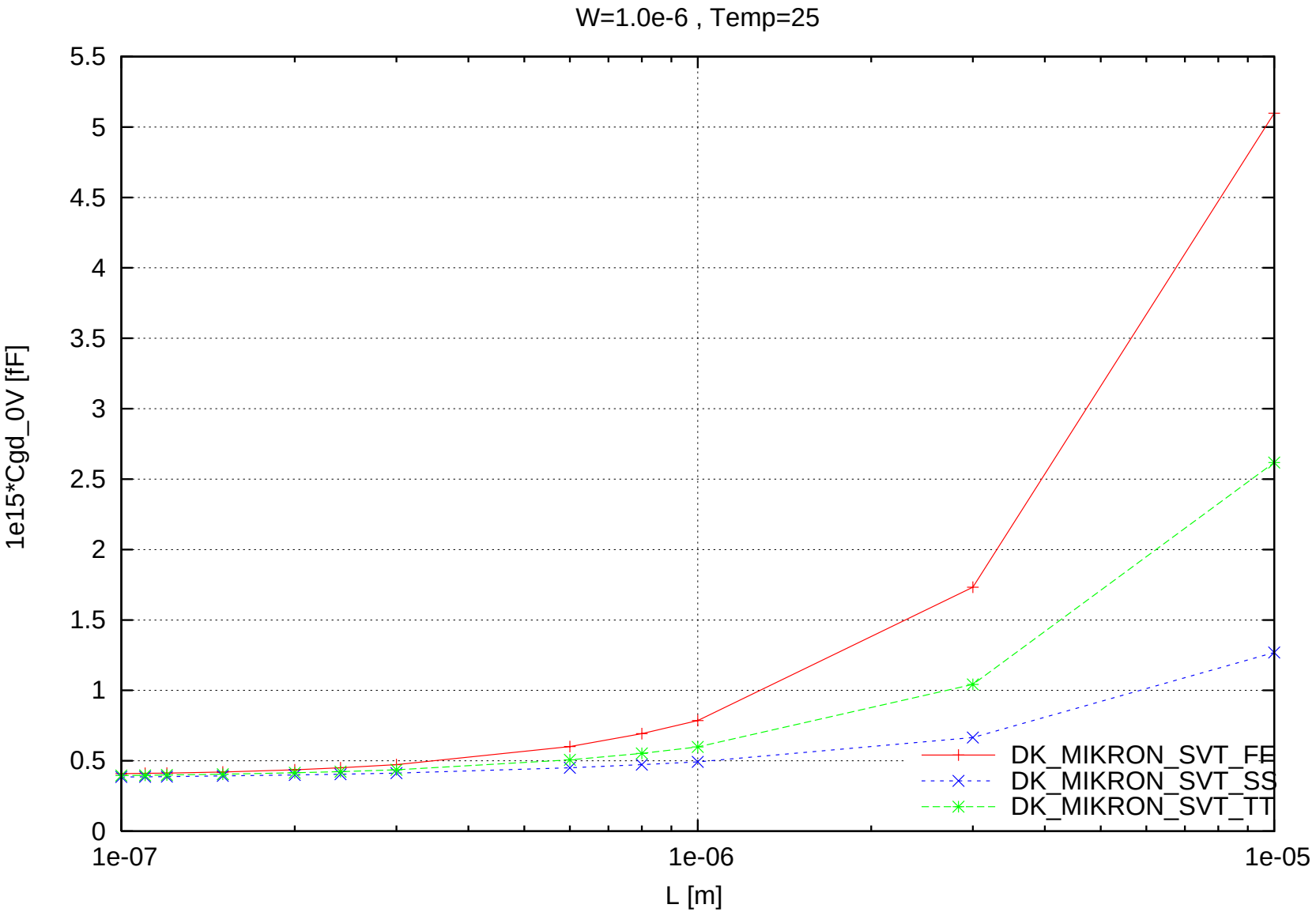
psvt 1e15*Cgg_inv/(W*L*1e12) [fF/sq] vs. L [m] , W=1.0e-6 , Temp=25



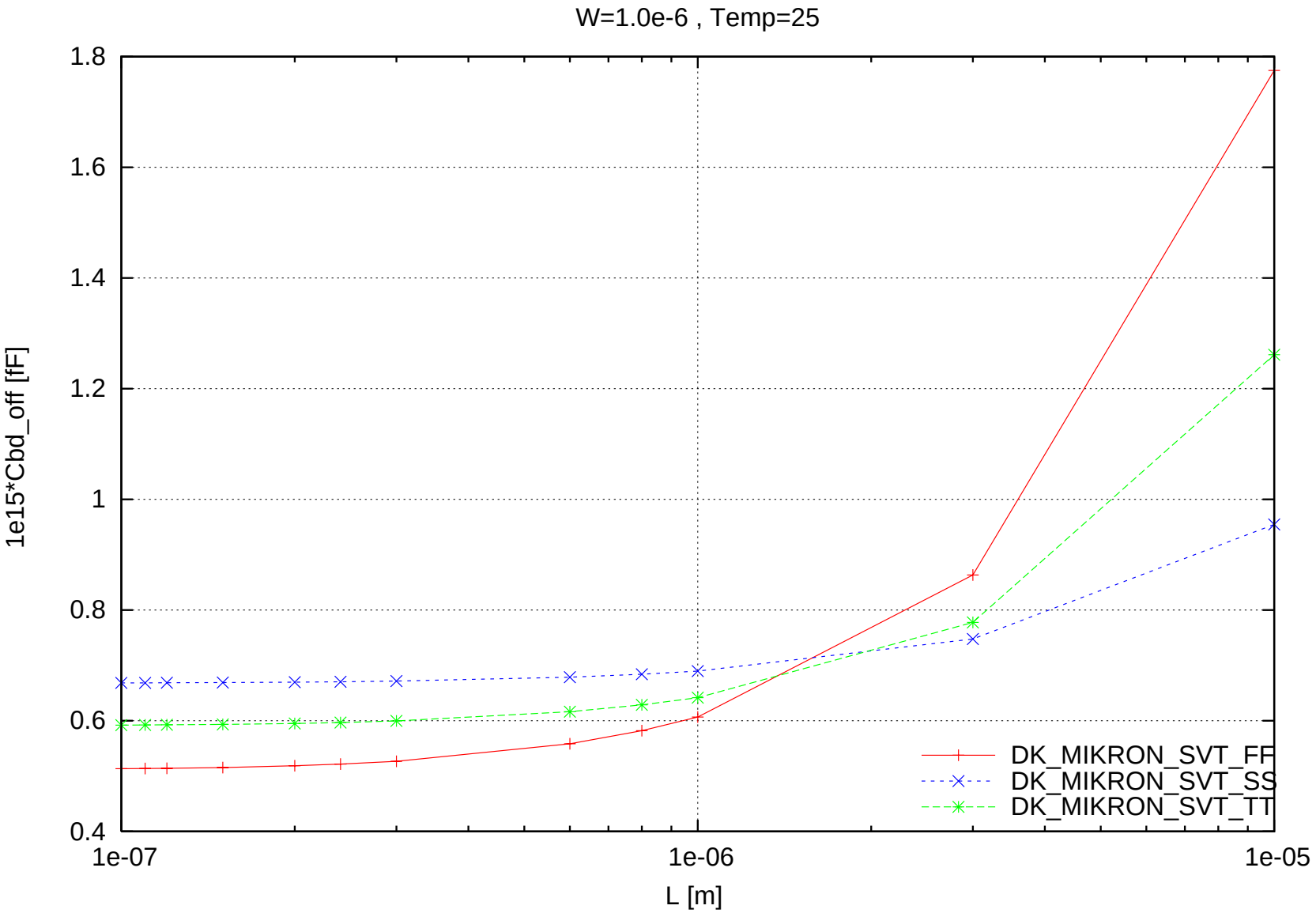
psvt 1e15*Cggmean/(W*L*1e12) [fF/sq] vs. L [m] , W=1.0e-6 , Temp=25



psvt 1e15*Cgd_0V [fF] vs. L [m] , W=1.0e-6 , Temp=25

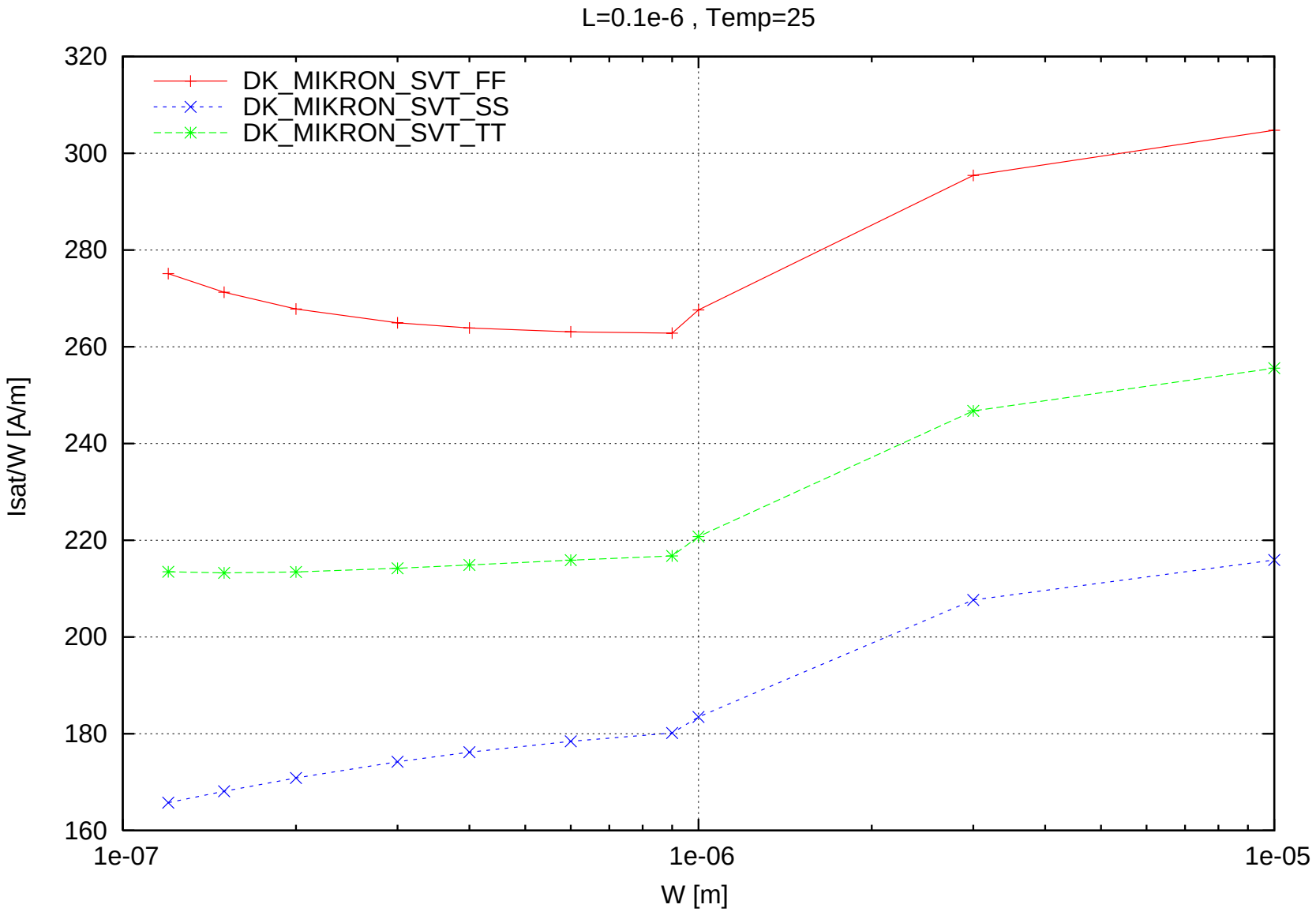


psvt 1e15*Cbd_off [fF] vs. L [m] , W=1.0e-6 , Temp=25

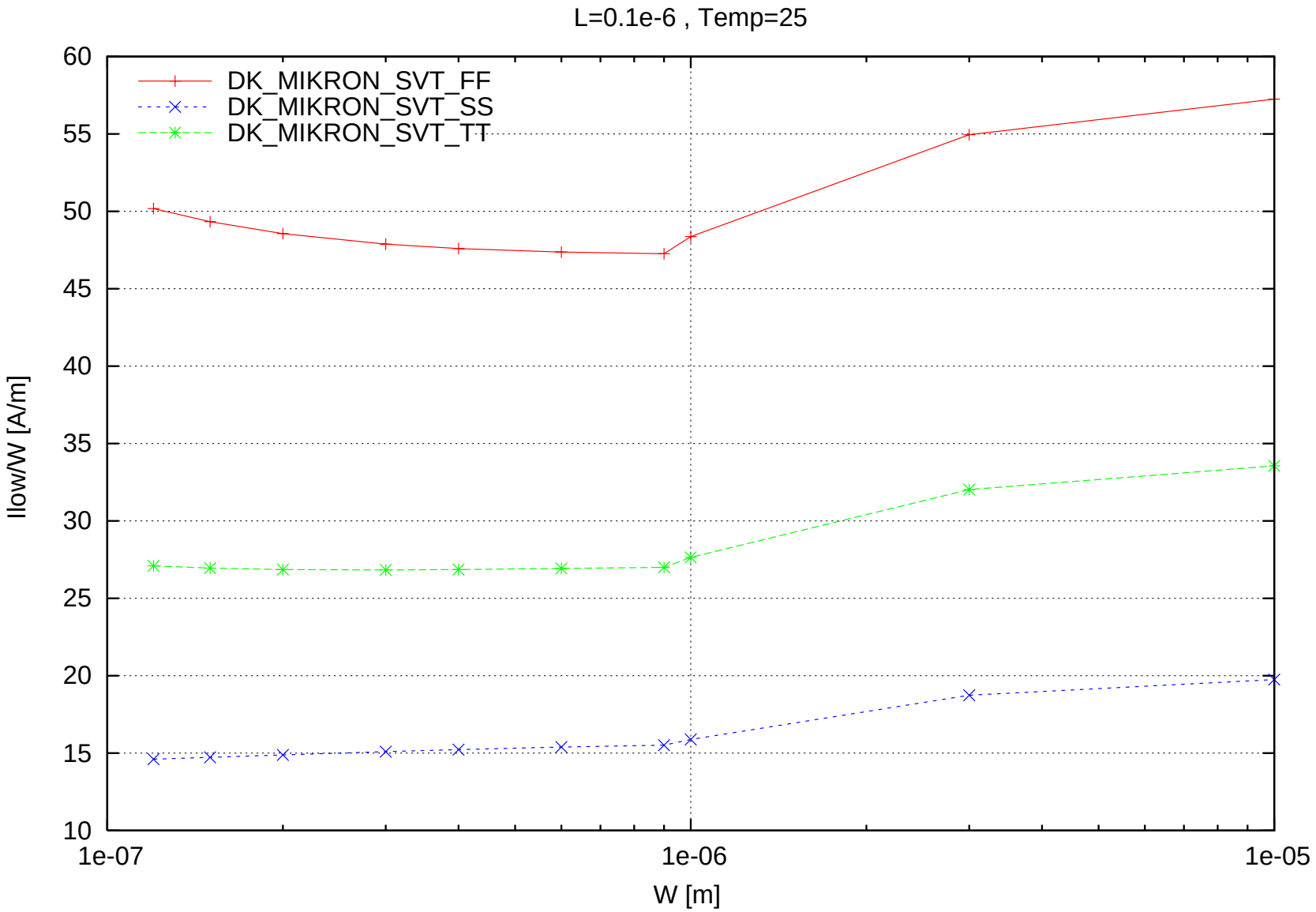


Scaling versus Width for PMOS (L=0.1e-6, Temp=25, po2act=0.63e-6, LPE=0)

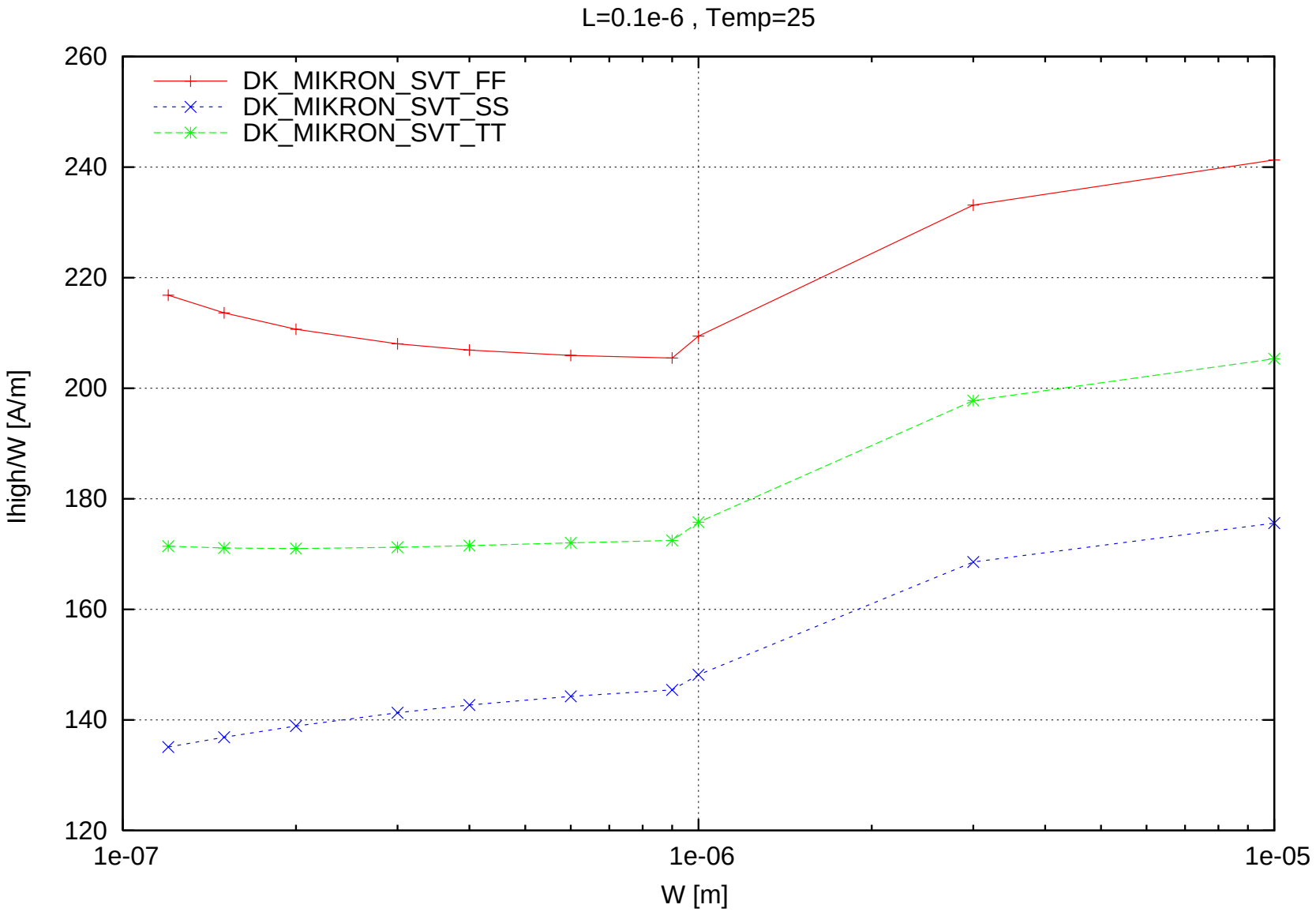
psvt Isat/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



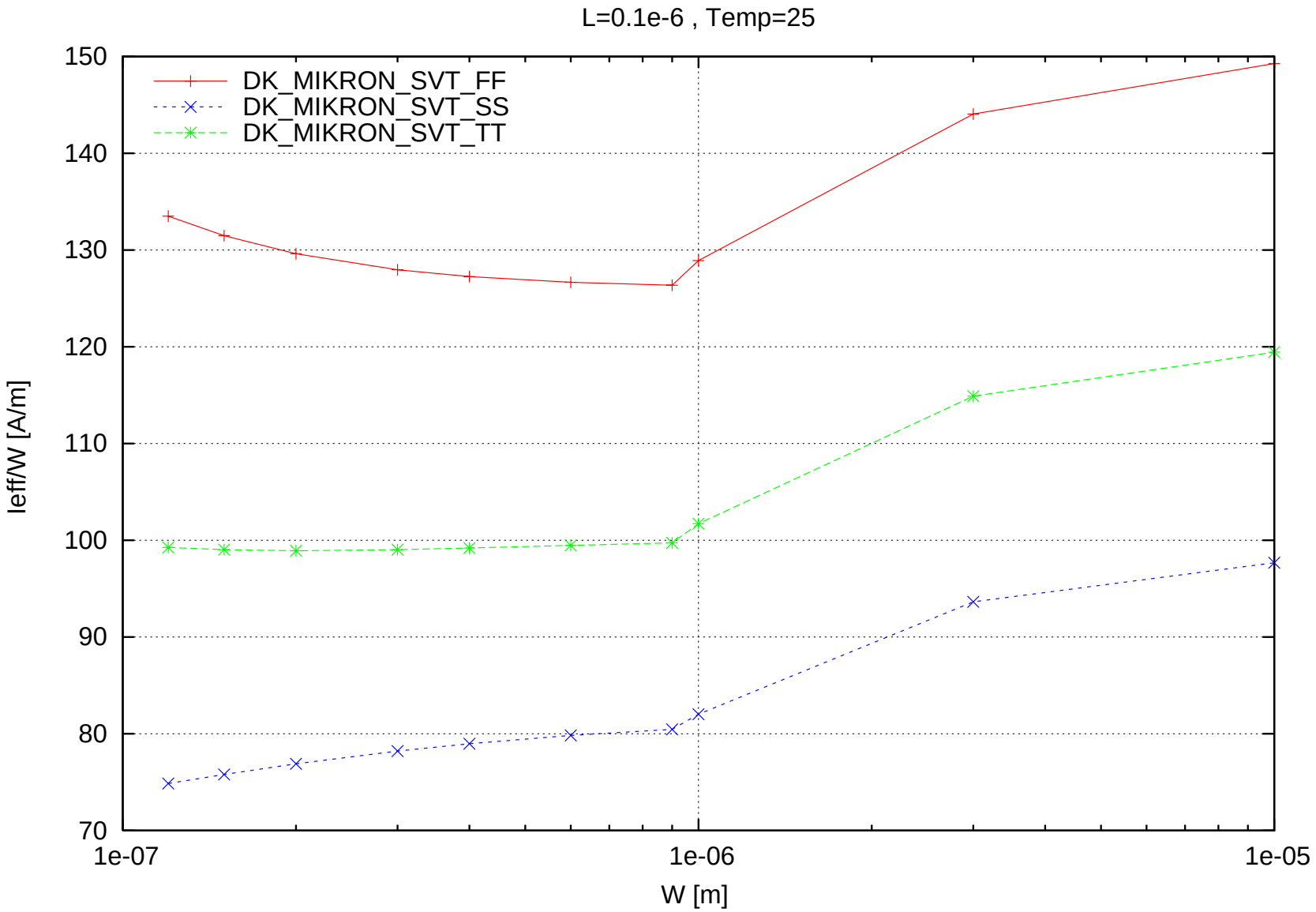
psvt Ilow/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



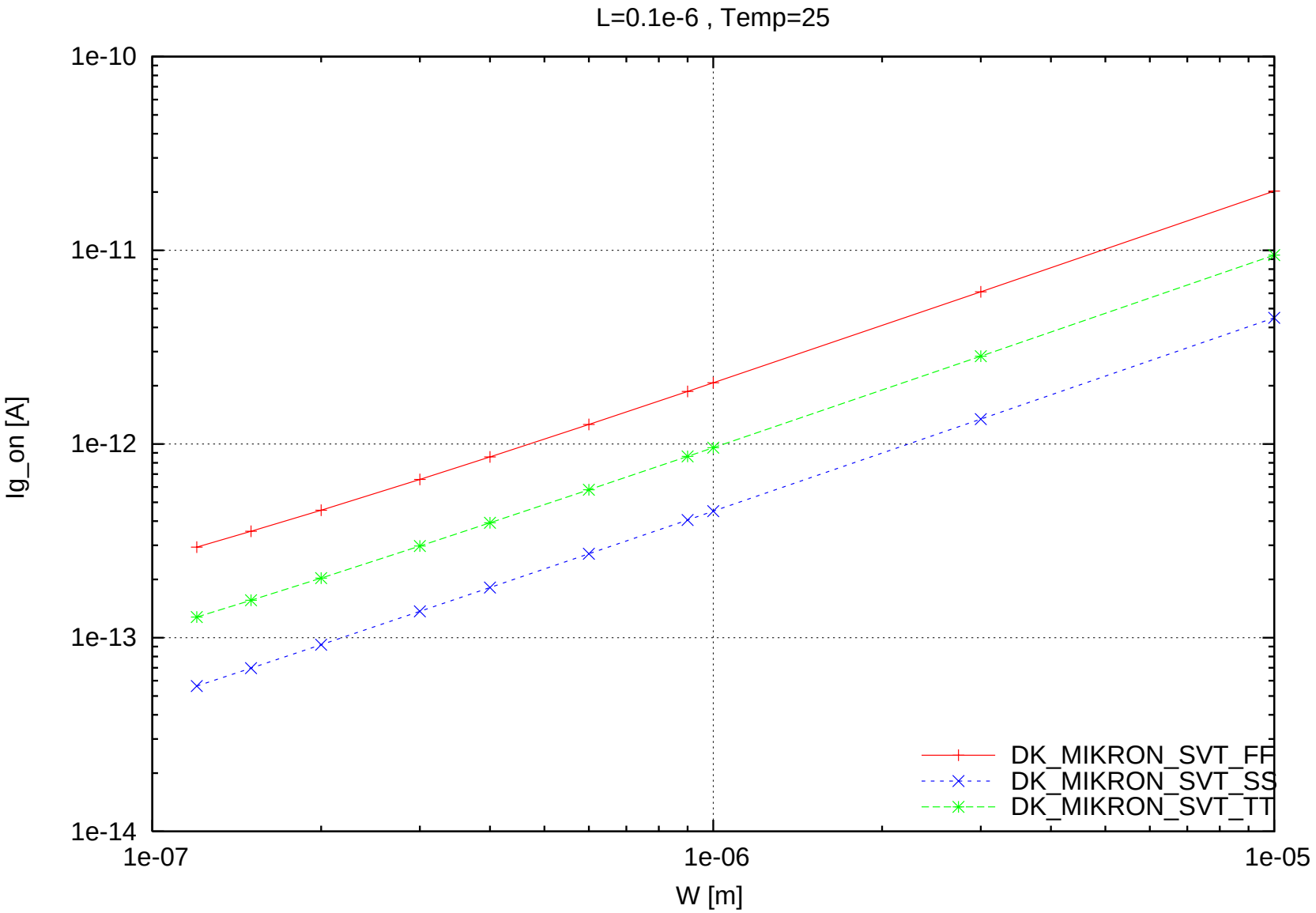
psvt Ihigh/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



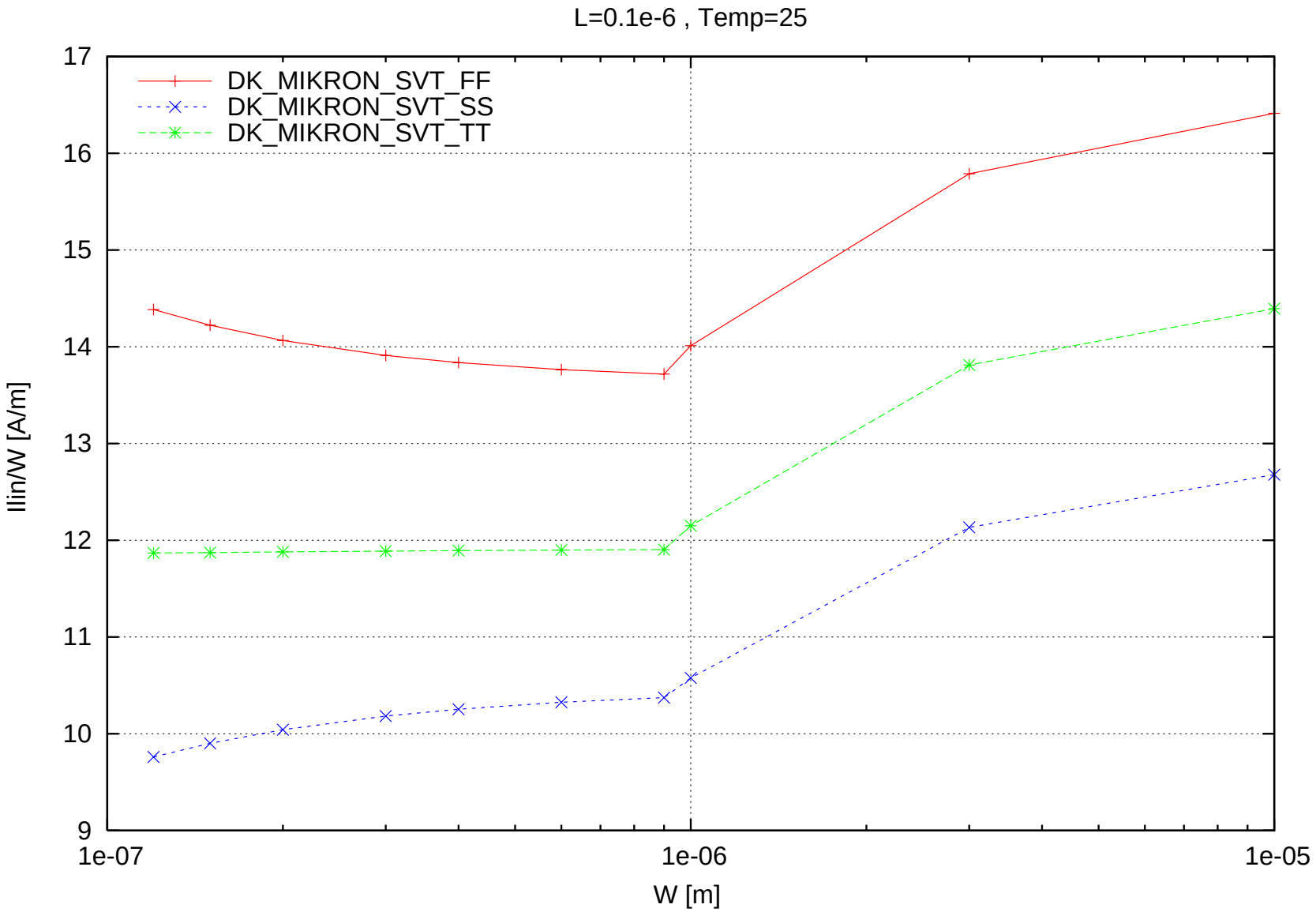
psvt Ieff/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



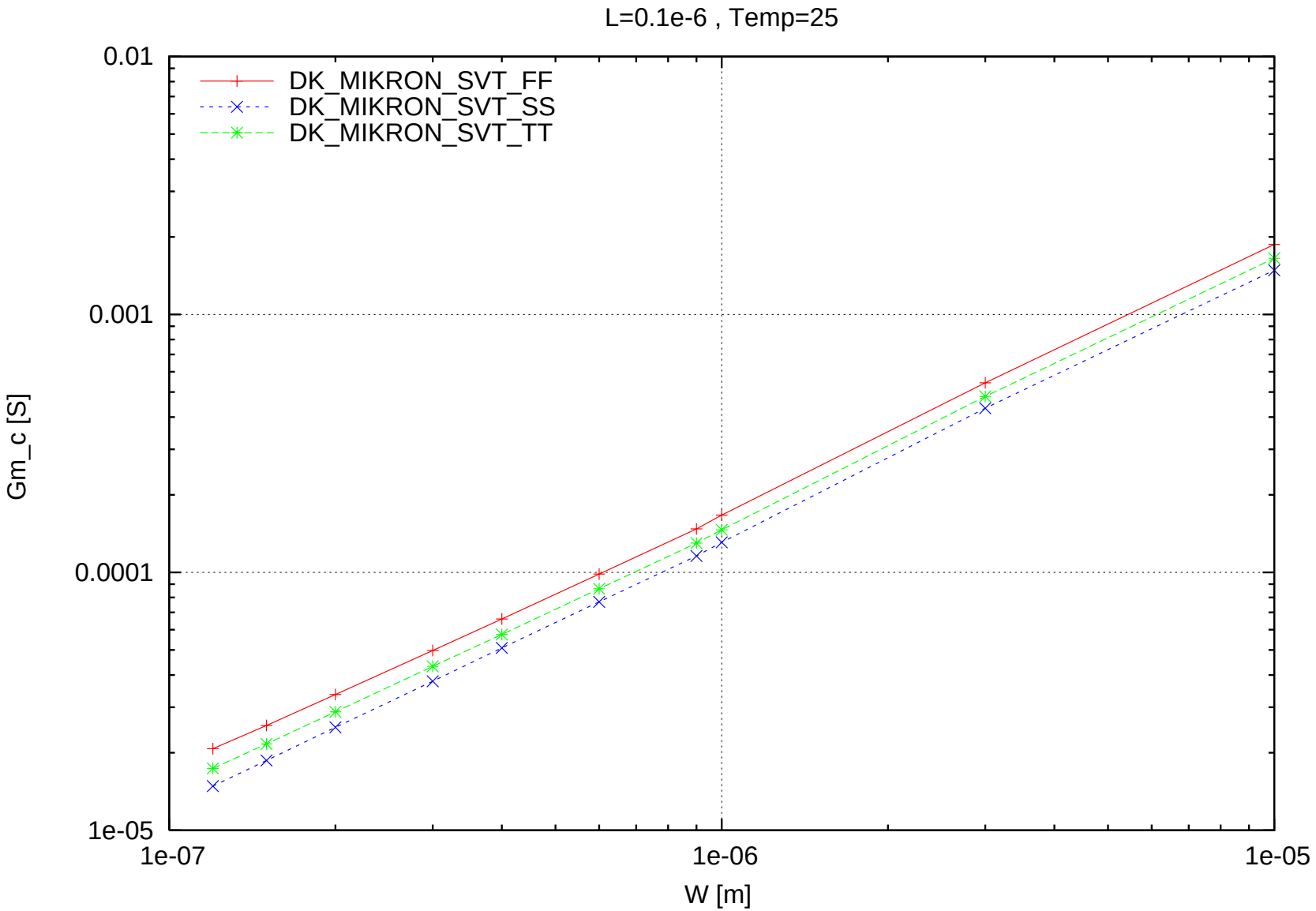
psvt Ig_on [A] vs. W [m] , L=0.1e-6 , Temp=25



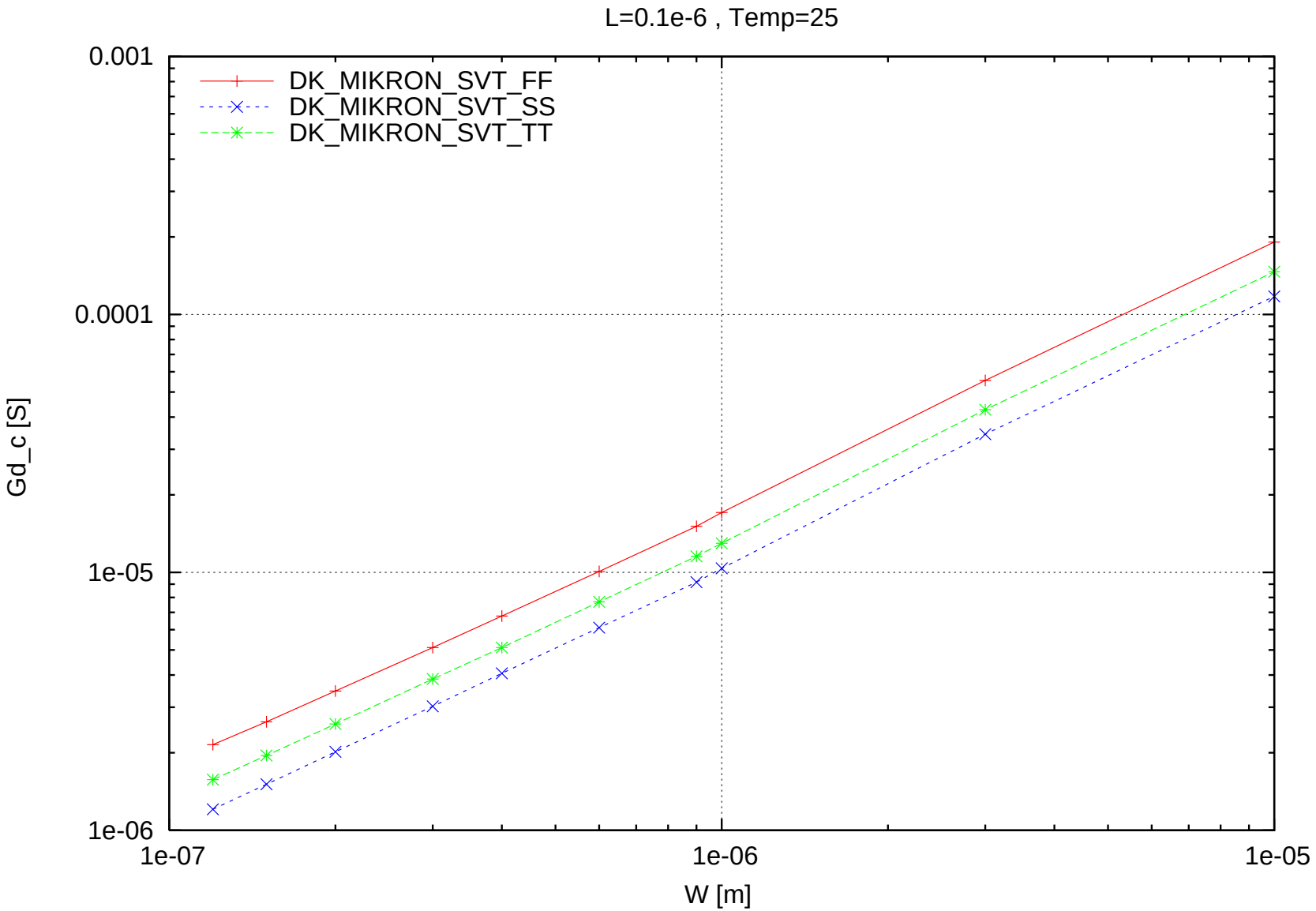
psvt Ilin/W [A/m] vs. W [m] , L=0.1e-6 , Temp=25



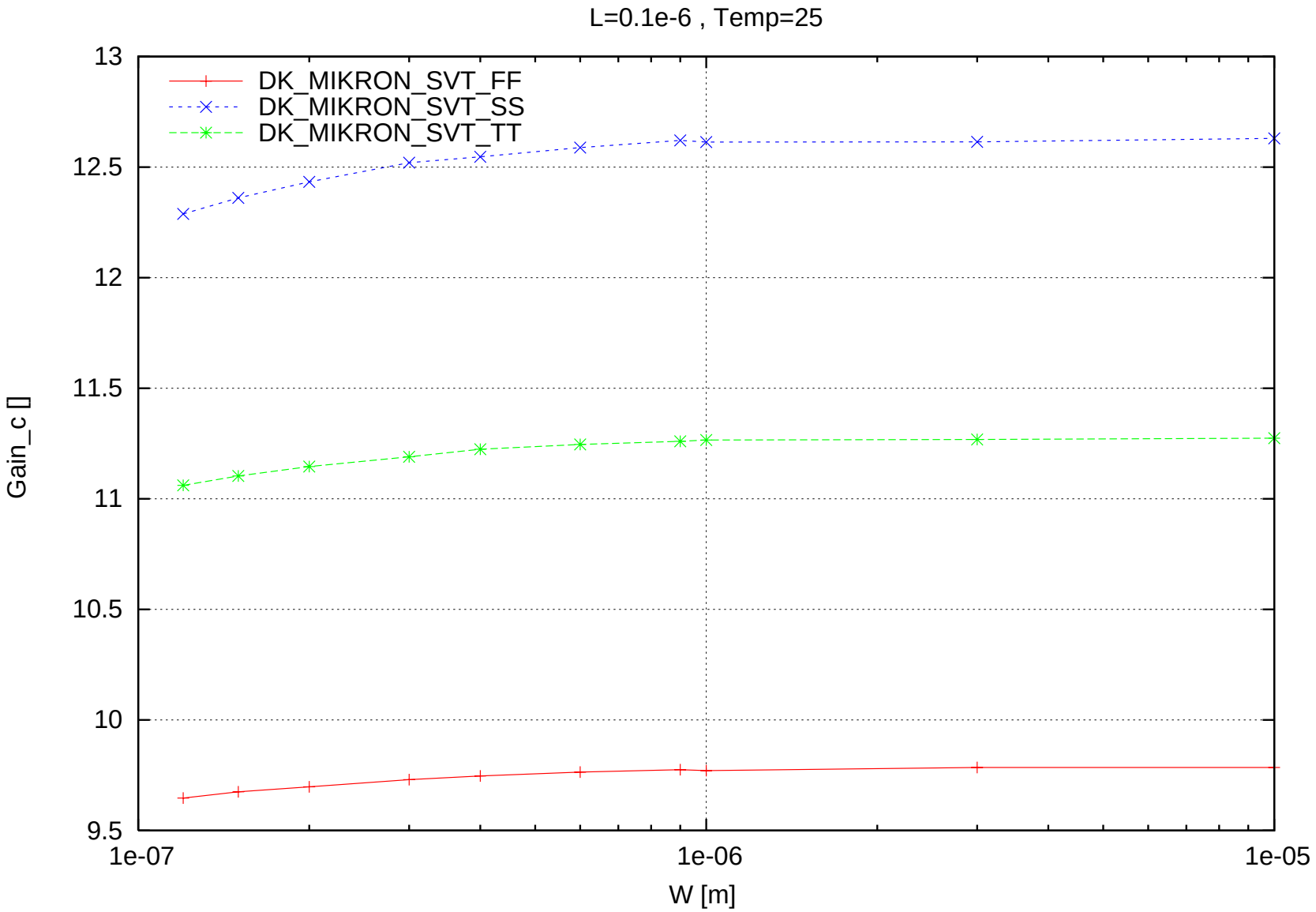
psvt Gm_c [S] vs. W [m] , L=0.1e-6 , Temp=25



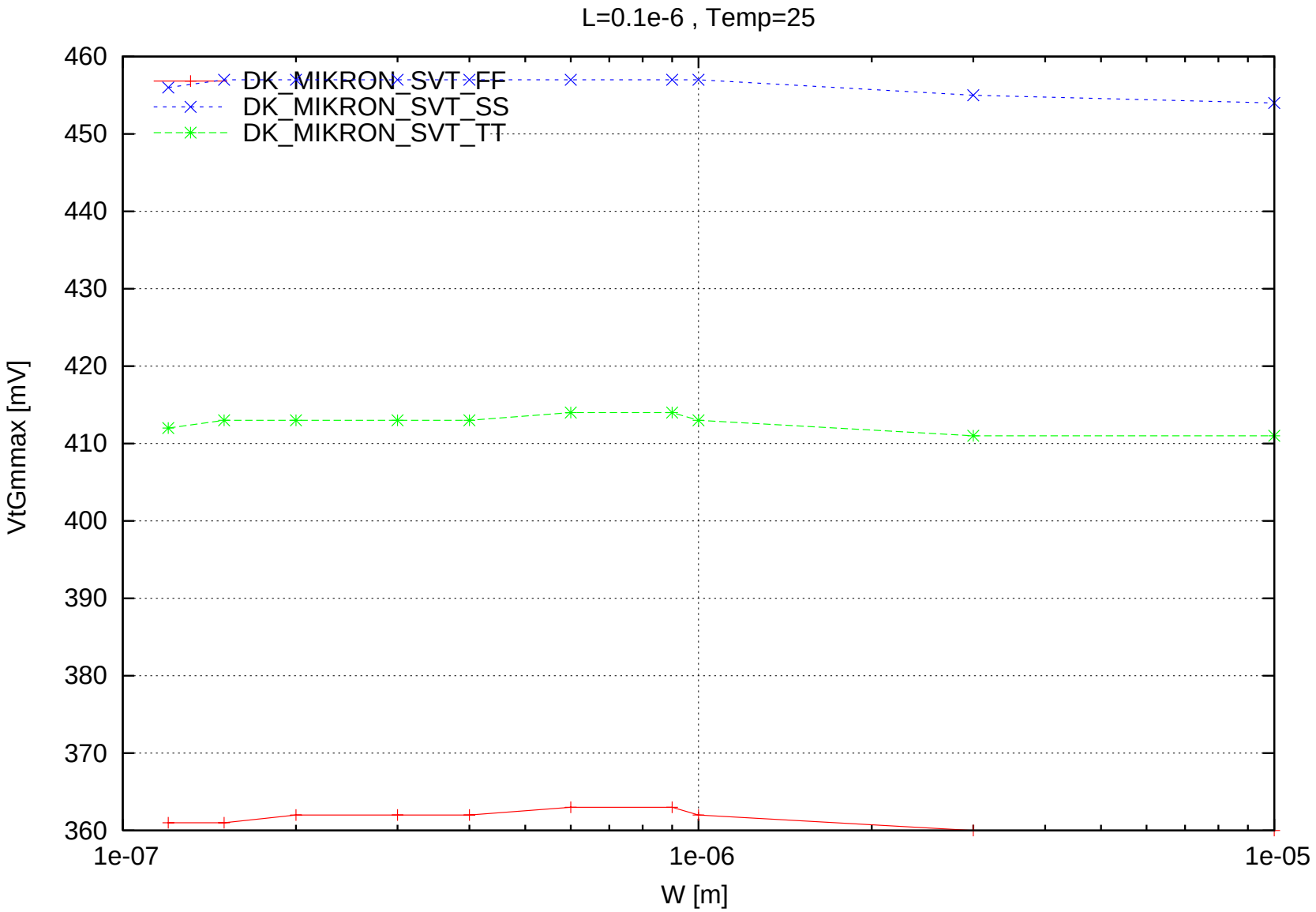
psvt Gd_c [S] vs. W [m] , L=0.1e-6 , Temp=25



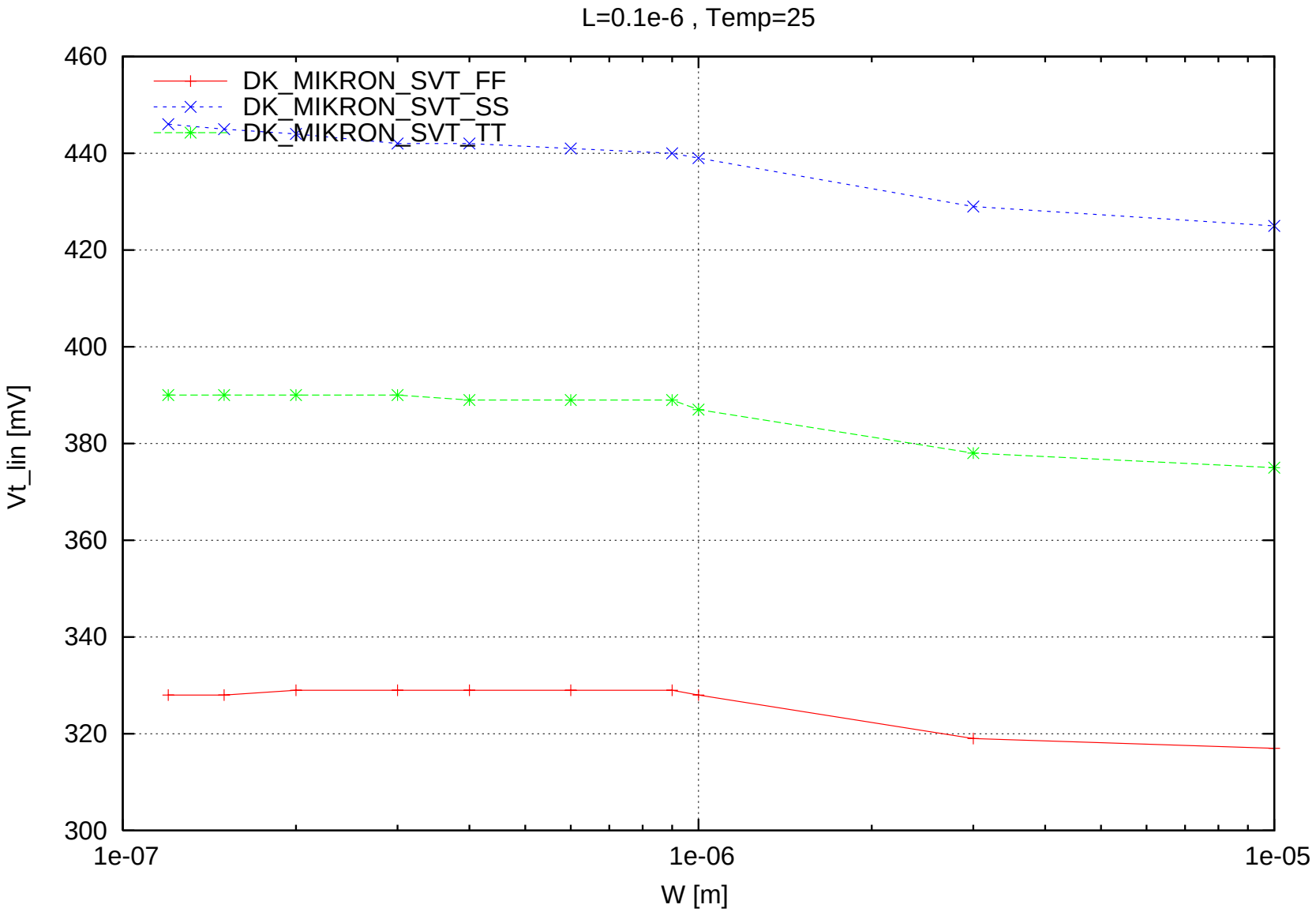
psvt Gain_c [] vs. W [m] , L=0.1e-6 , Temp=25



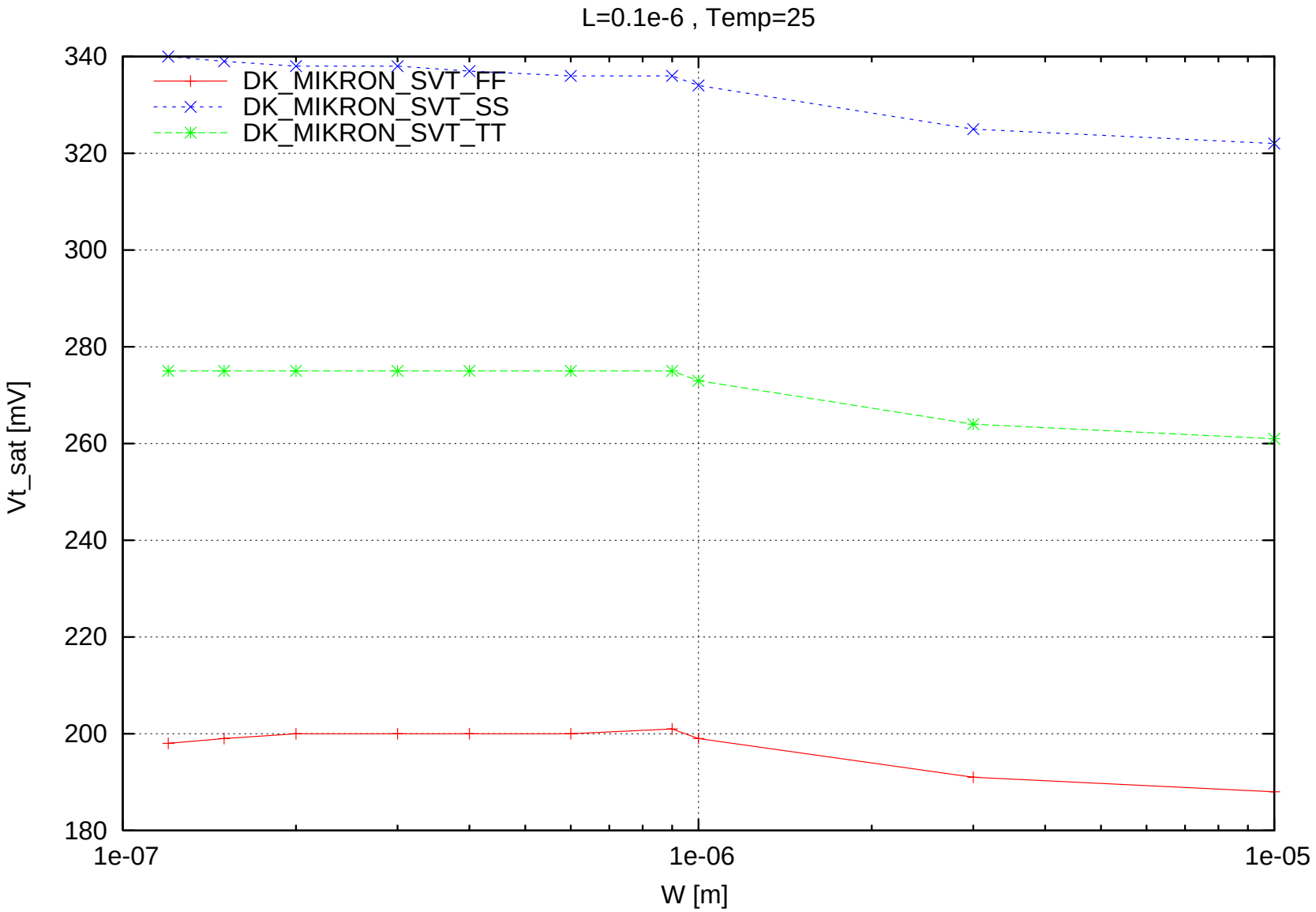
psvt VtGmmax [mV] vs. W [m] , L=0.1e-6 , Temp=25



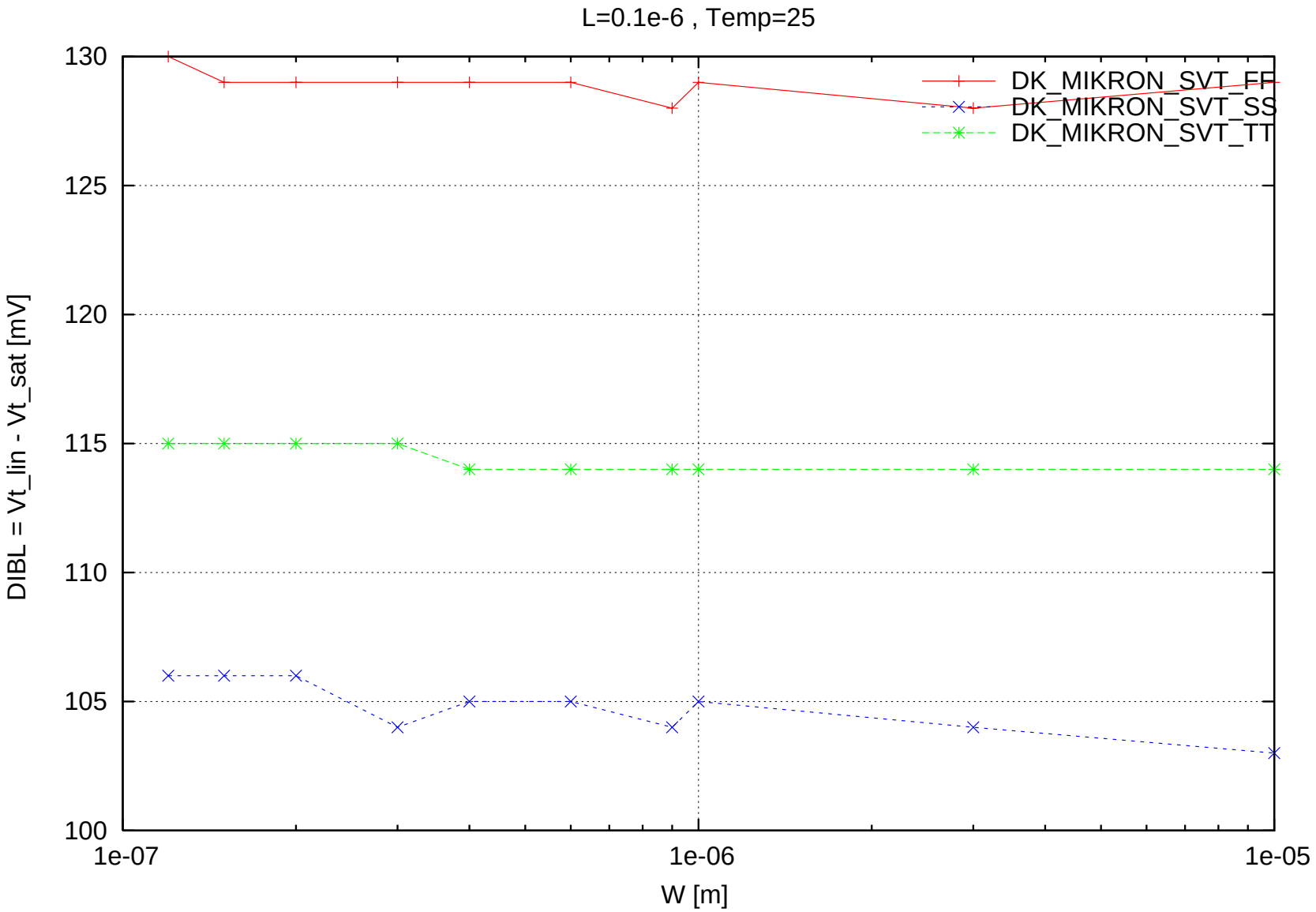
psvt Vt_lin [mV] vs. W [m] , L=0.1e-6 , Temp=25



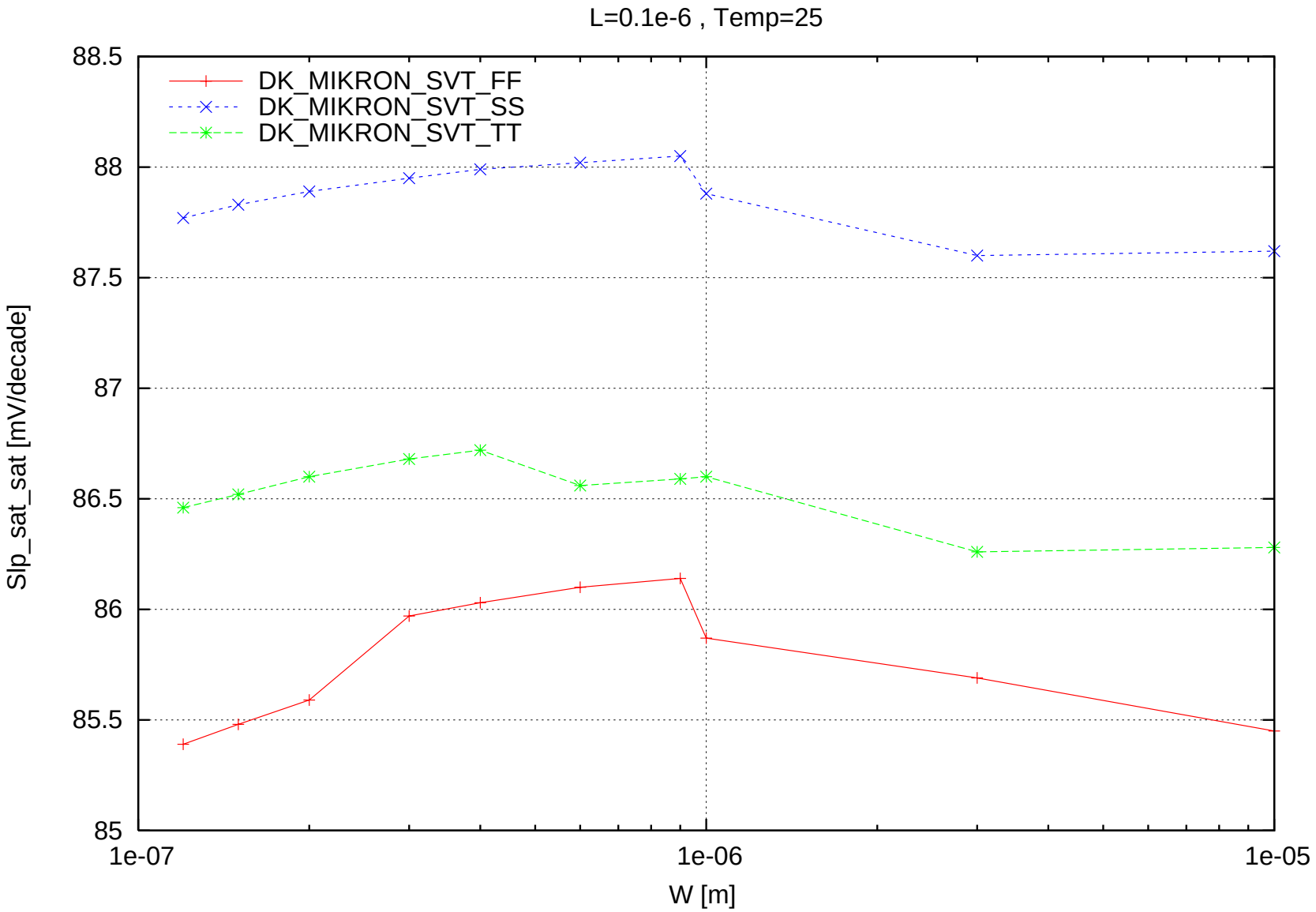
psvt Vt_sat [mV] vs. W [m] , L=0.1e-6 , Temp=25



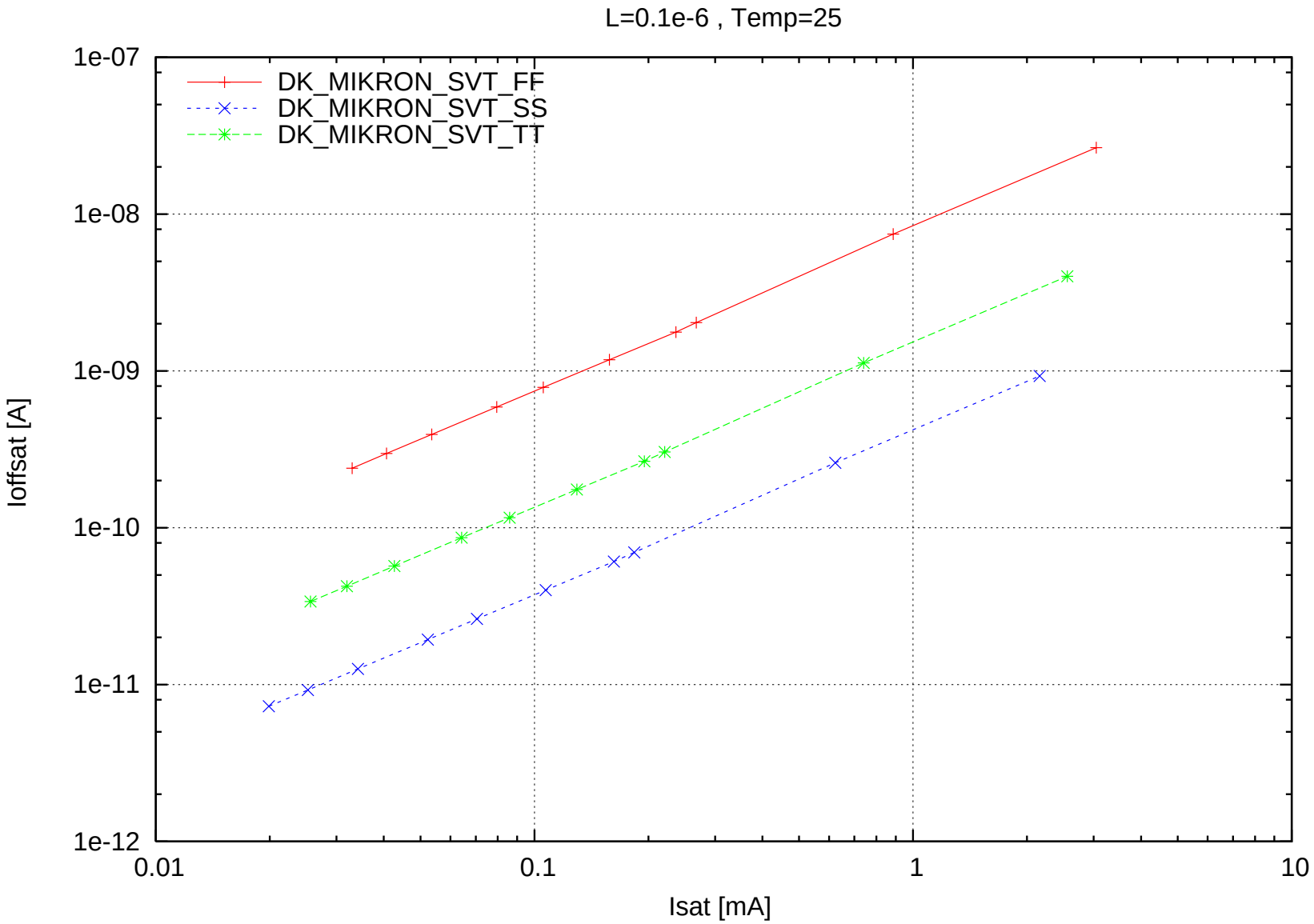
psvt DIBL = Vt_lin - Vt_sat [mV] vs. W [m] , L=0.1e-6 , Temp=25



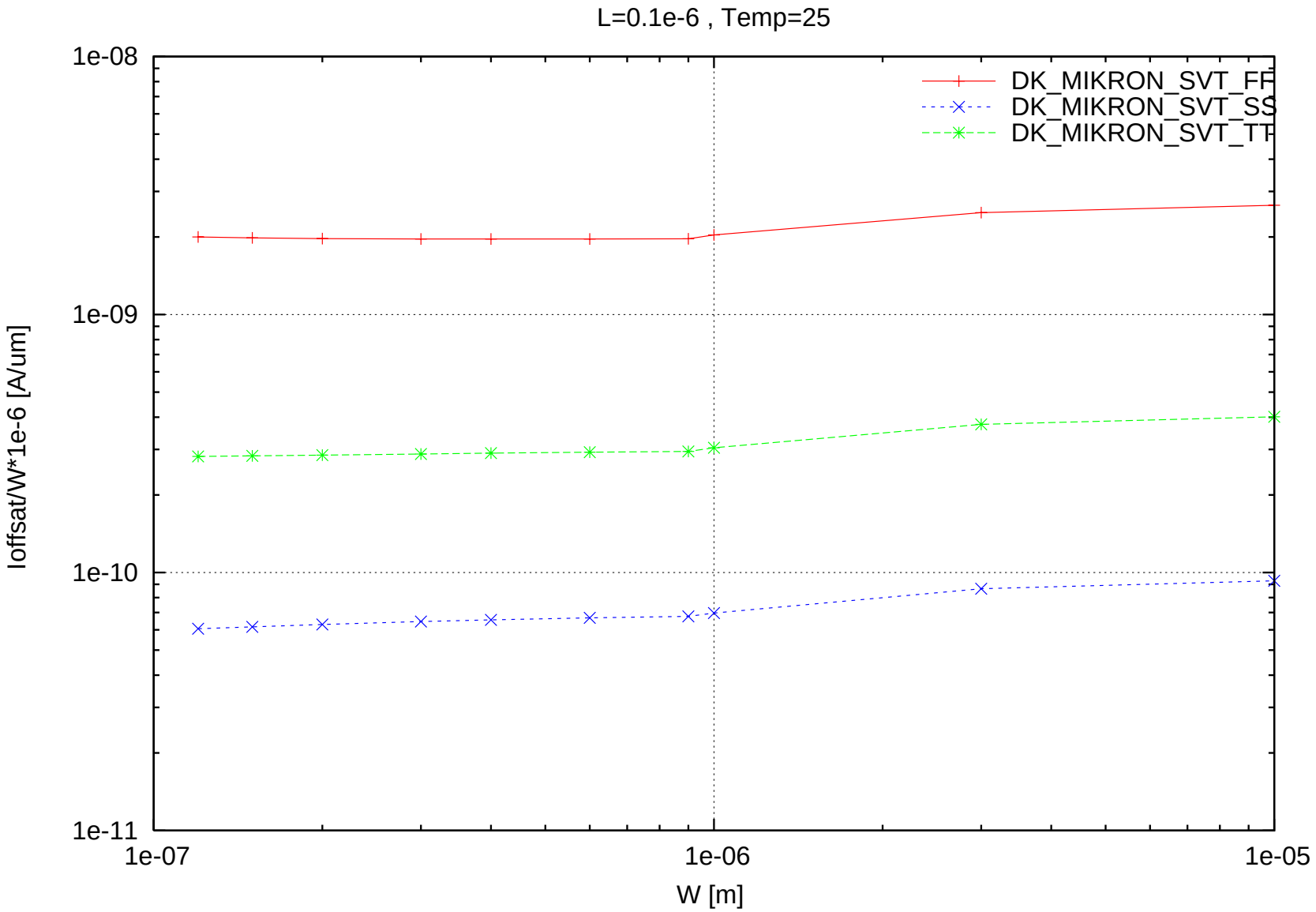
psvt Slp_sat_sat [mV/decade] vs. W [m] , L=0.1e-6 , Temp=25



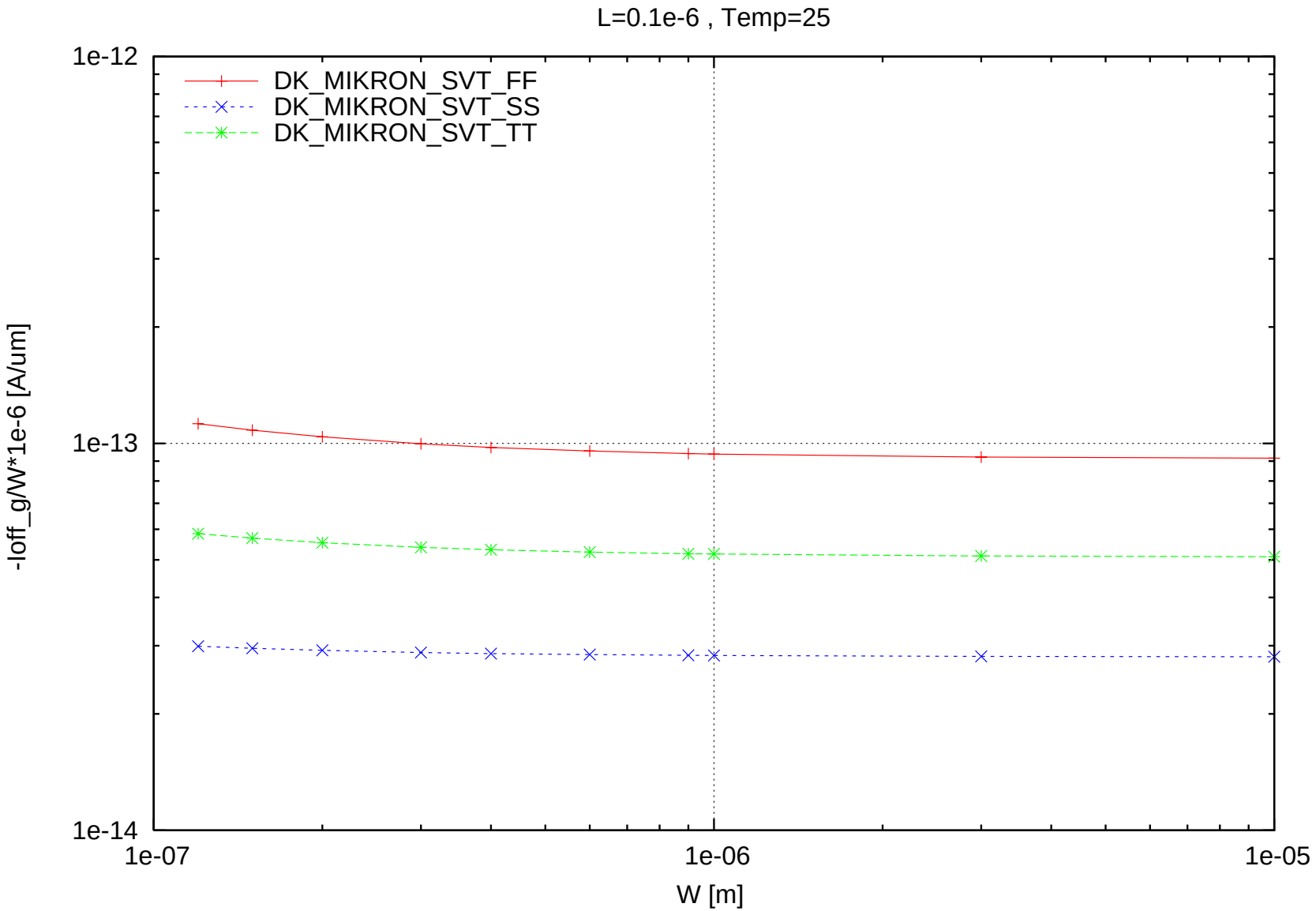
psvt Ioffsat [A] vs. Isat [mA] , L=0.1e-6 , Temp=25



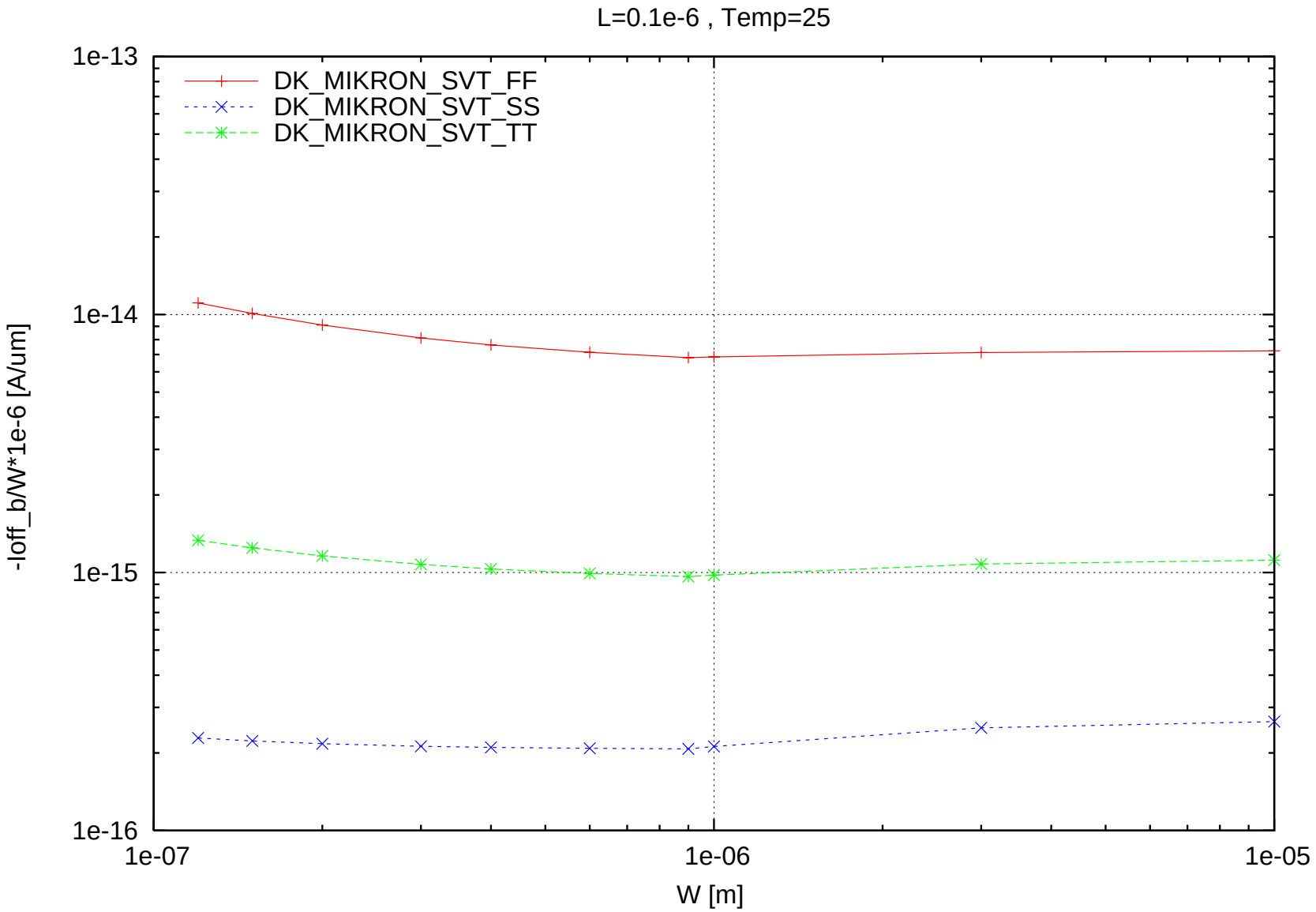
psvt Ioffsat/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



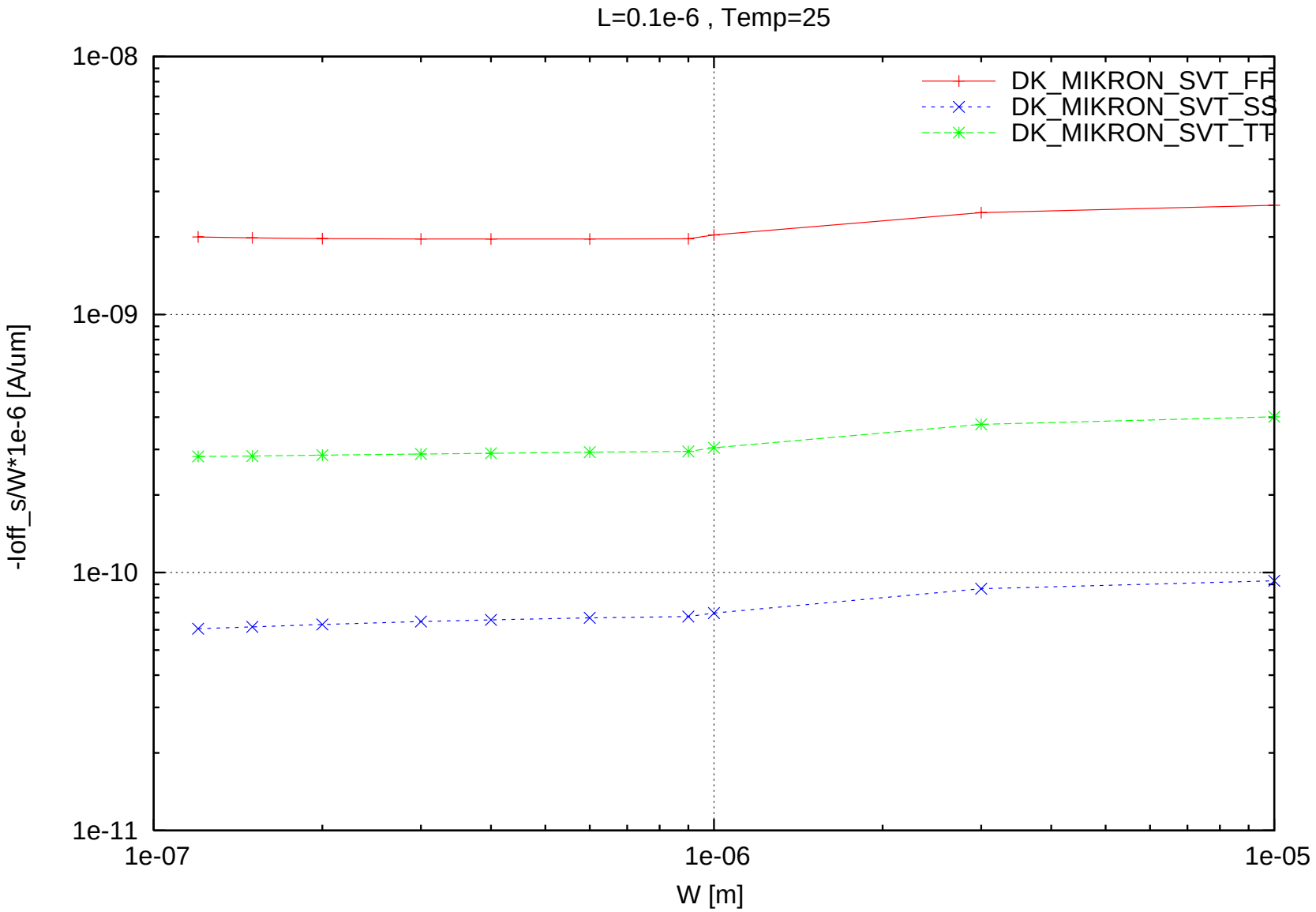
psvt -Ioff_g/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



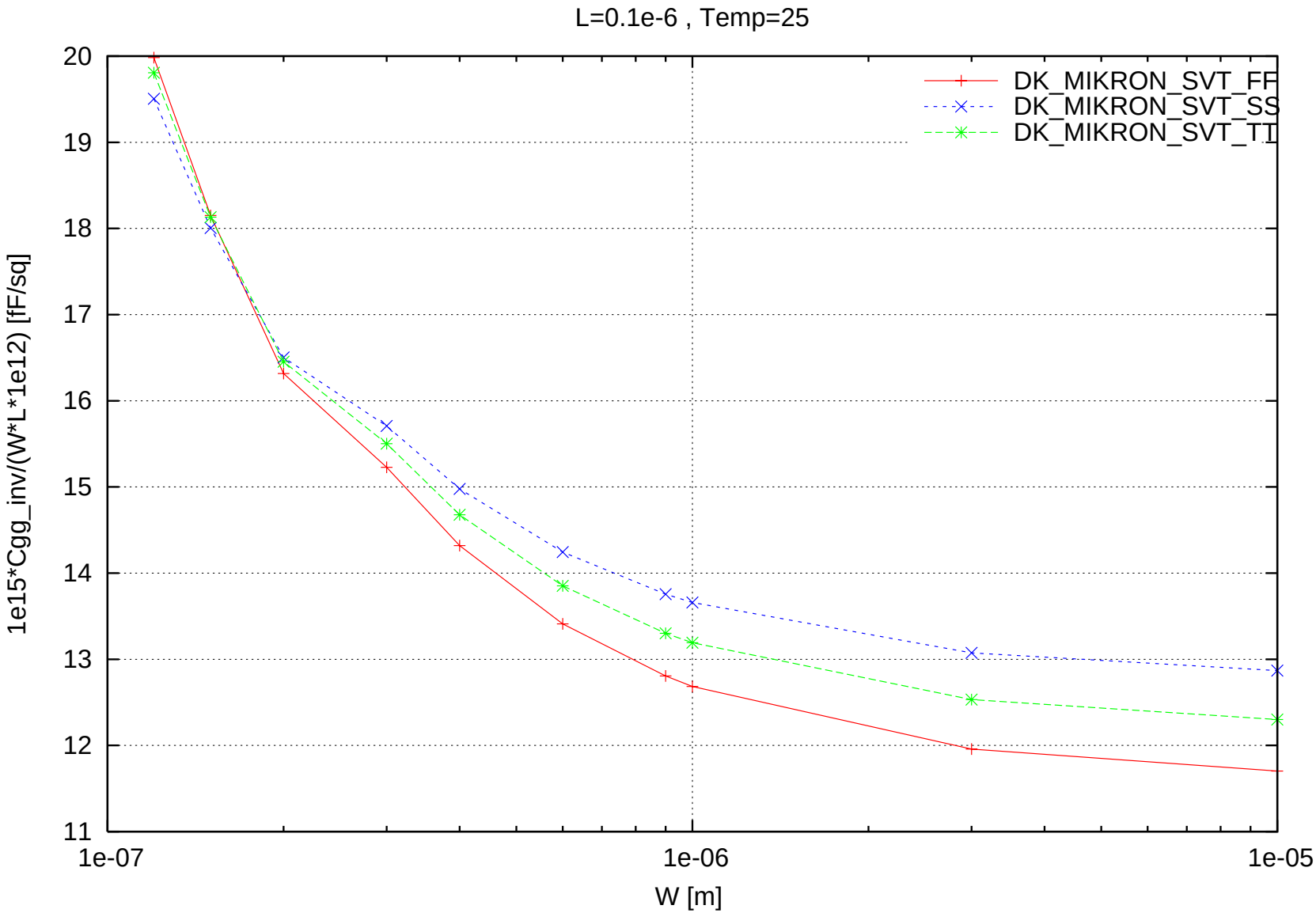
psvt -Ioff_b/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



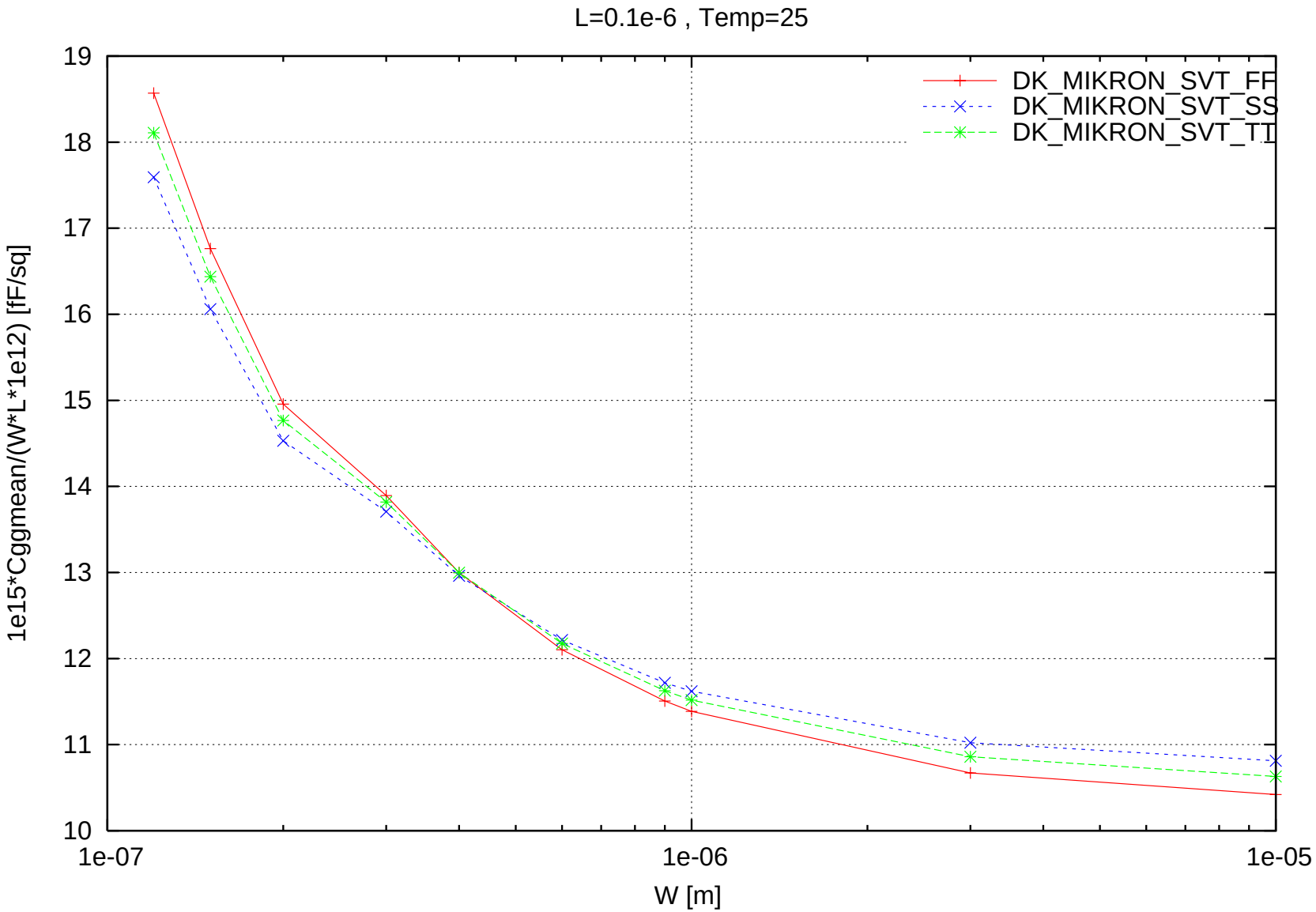
psvt -Ioff_s/W*1e-6 [A/um] vs. W [m] , L=0.1e-6 , Temp=25



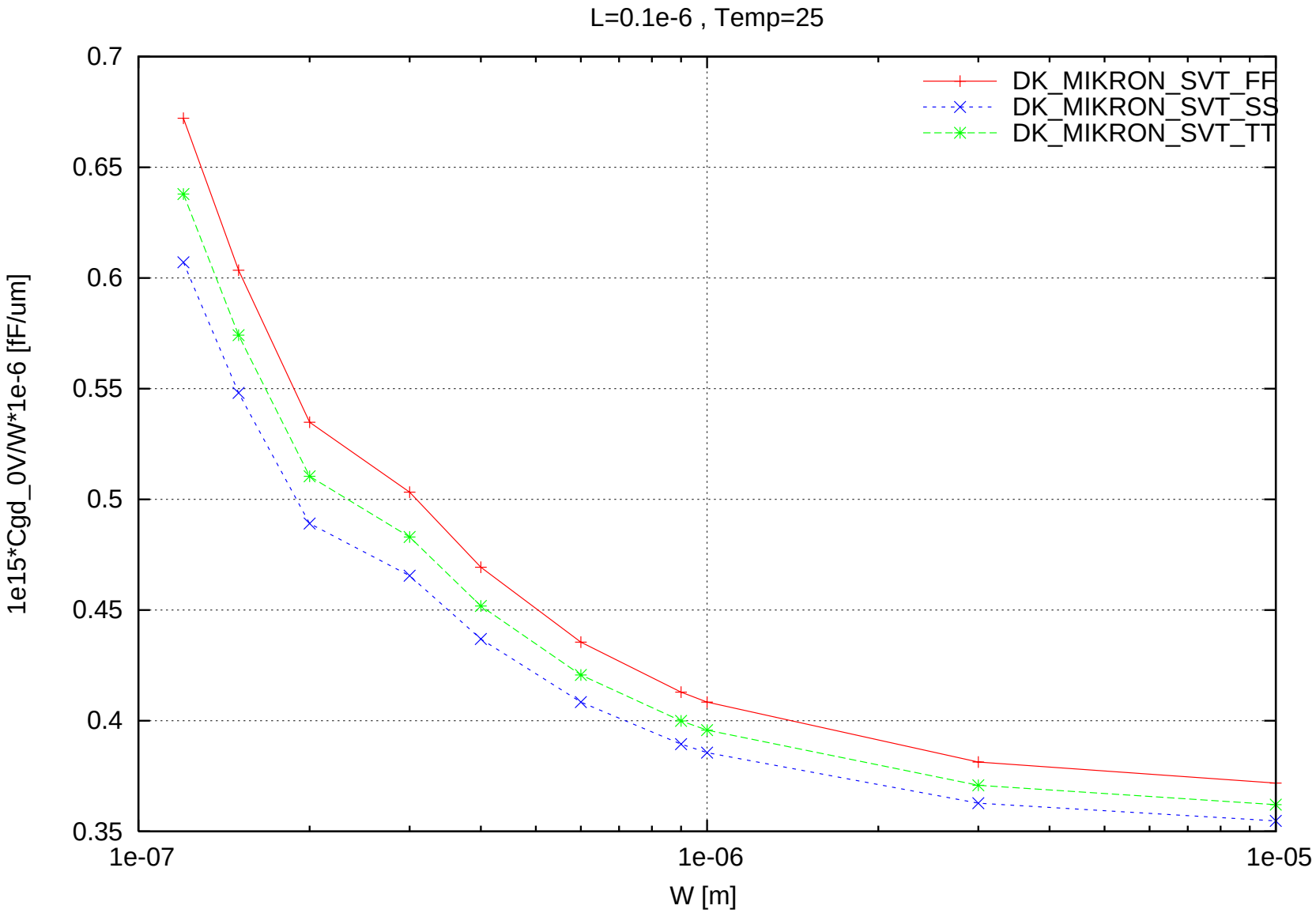
psvt 1e15*Cgg_inv/(W*L*1e12) [fF/sq] vs. W [m] , L=0.1e-6 , Temp=25



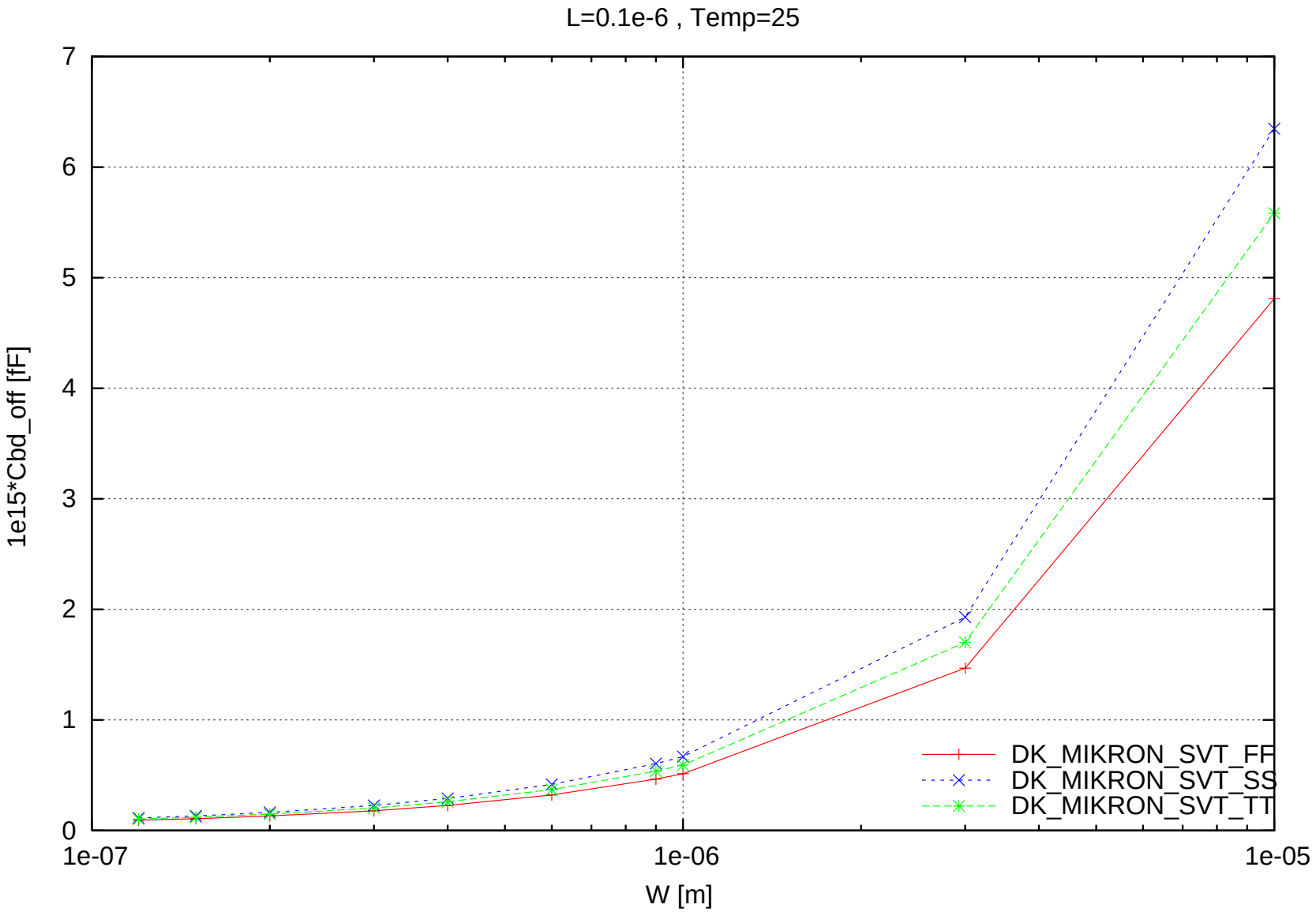
psvt 1e15*Cggmean/(W*L*1e12) [fF/sq] vs. W [m] , L=0.1e-6 , Temp=25



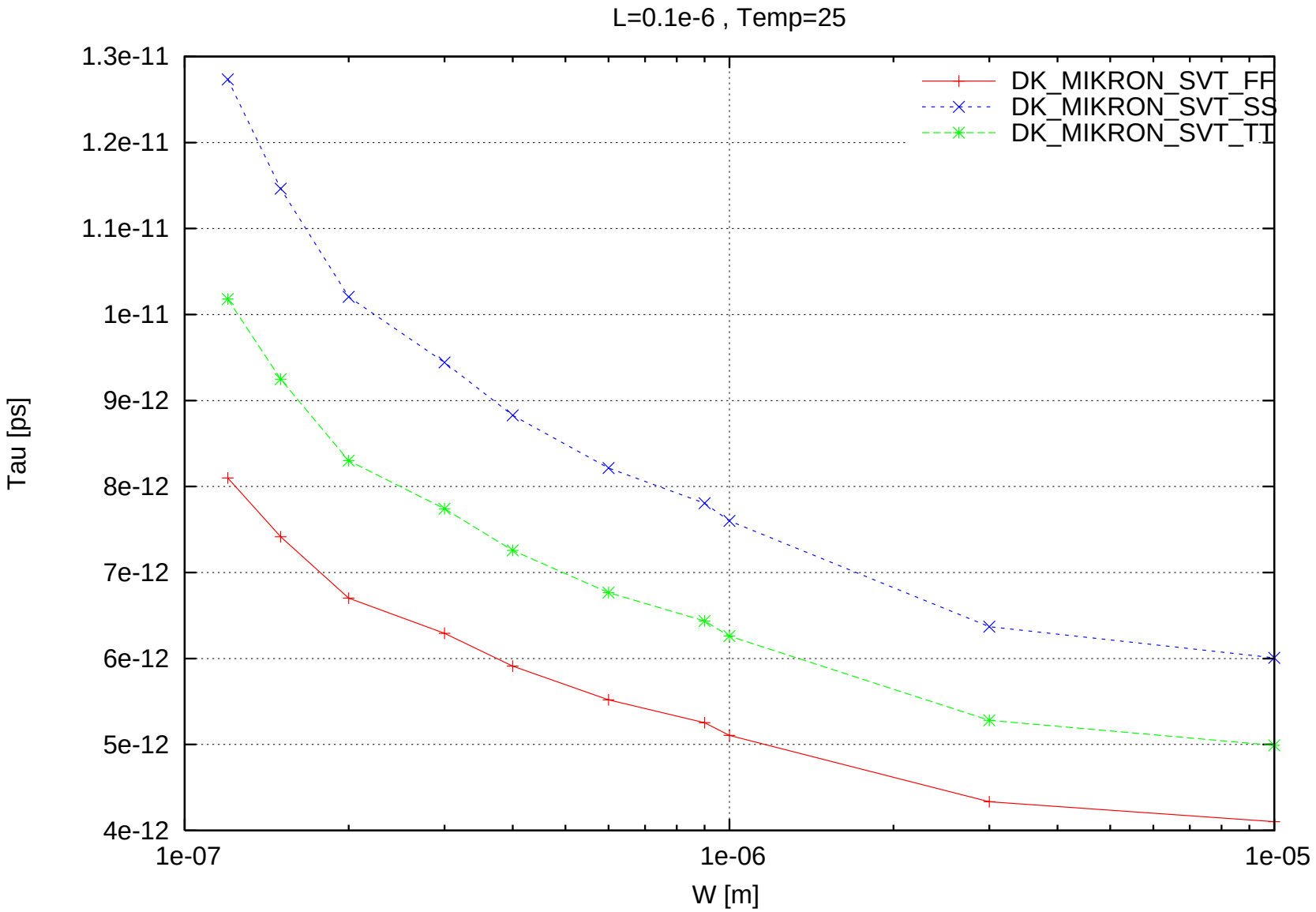
psvt 1e15*Cgd_0V/W*1e-6 [fF/um] vs. W [m] , L=0.1e-6 , Temp=25



psvt 1e15*Cbd_off [fF] vs. W [m] , L=0.1e-6 , Temp=25

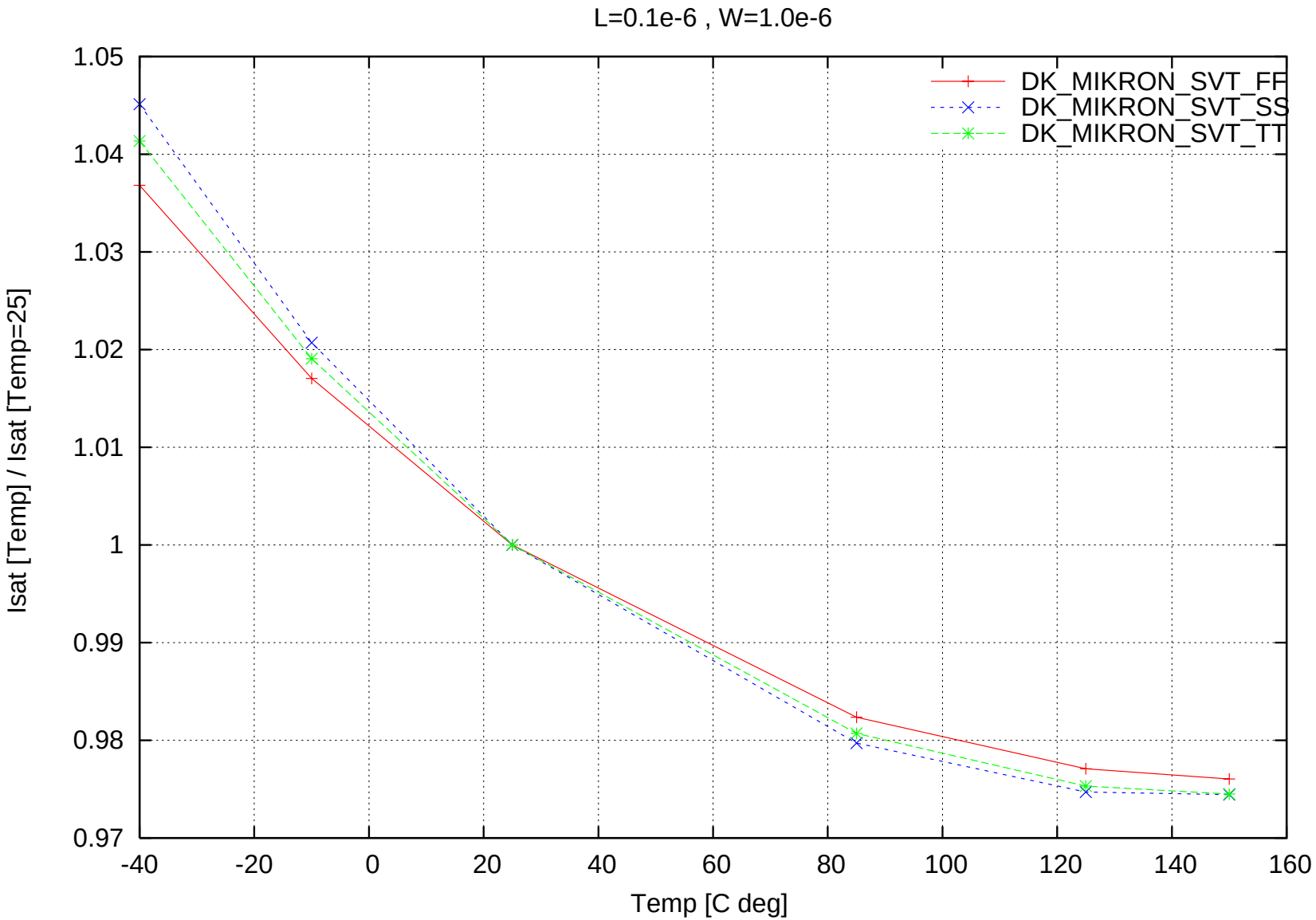


psvt Tau [ps] vs. W [m] , L=0.1e-6 , Temp=25

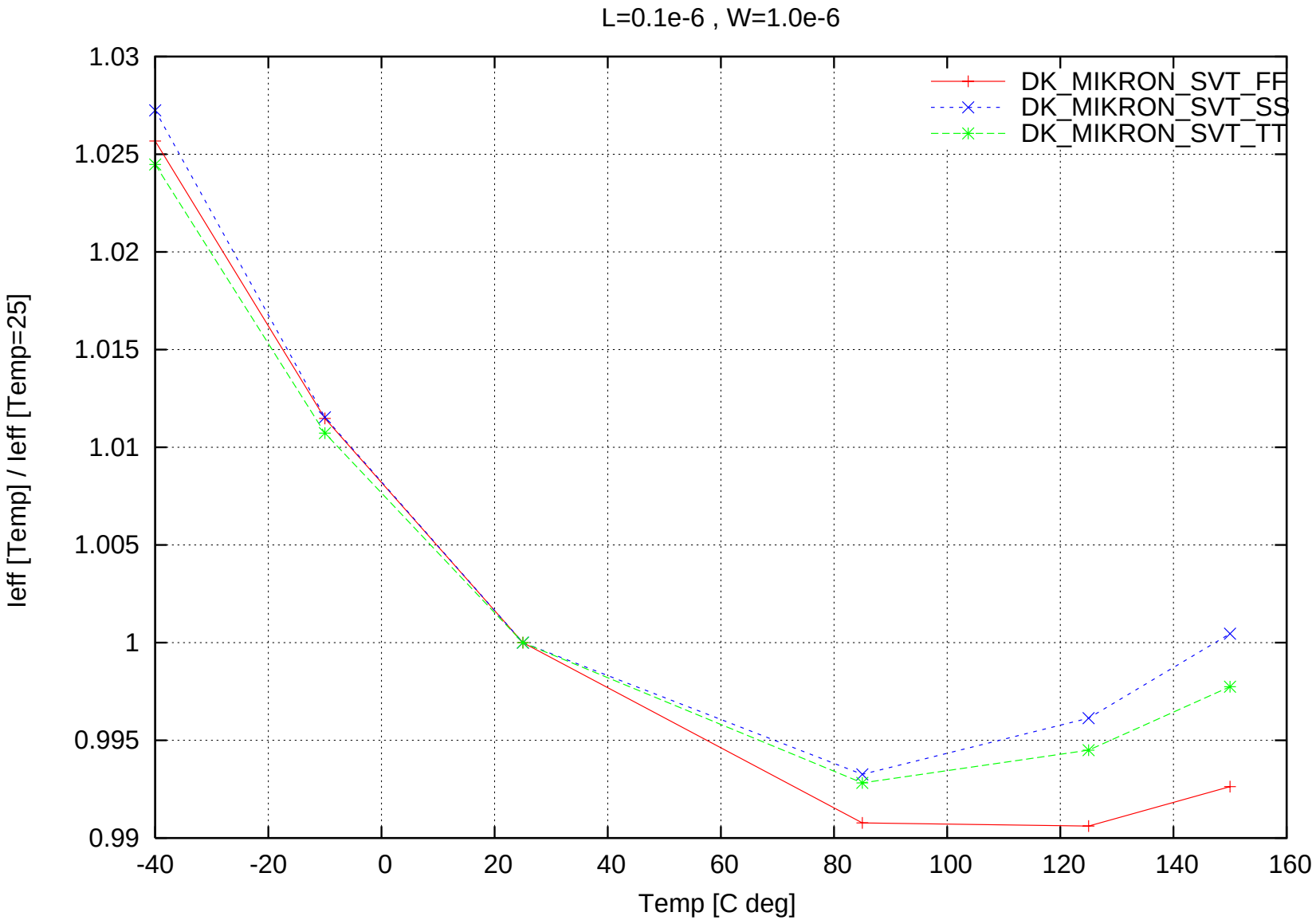


Scaling versus Temp for PMOS (L=0.1e-6, W=1.0e-6, po2act=0.63e-6, LPE=0)

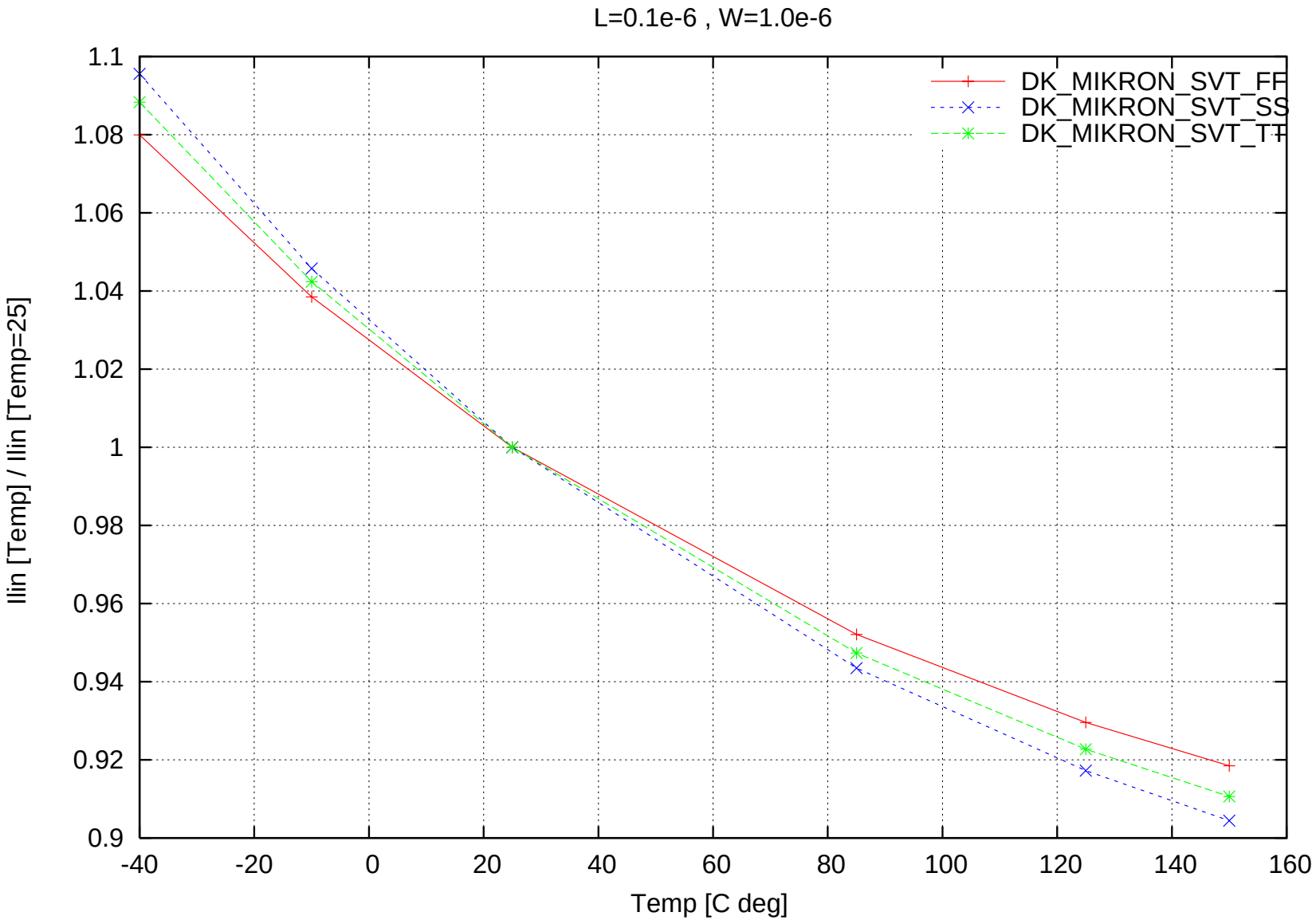
psvt Isat [Temp] / Isat [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



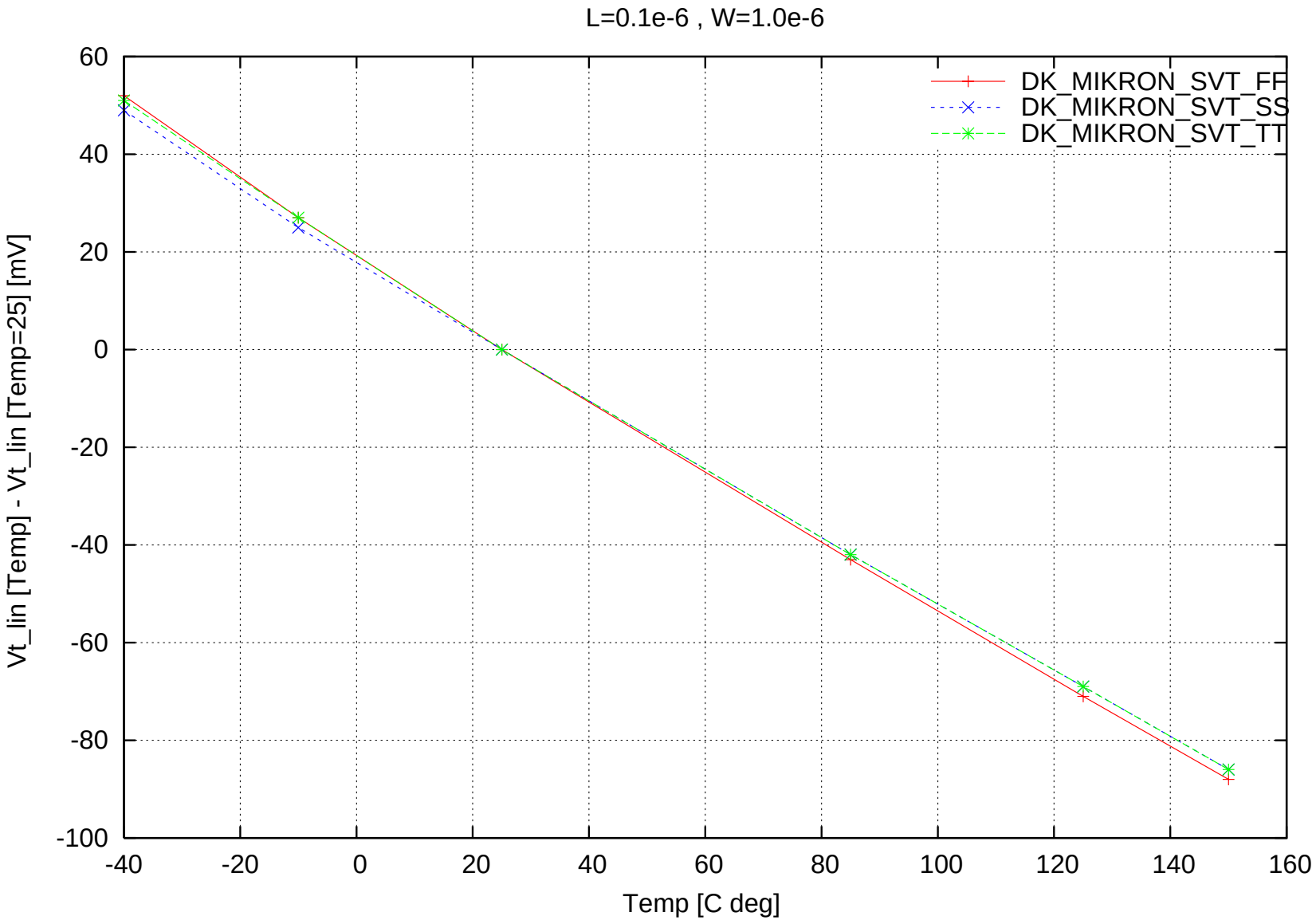
psvt Ieff [Temp] / Ieff [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



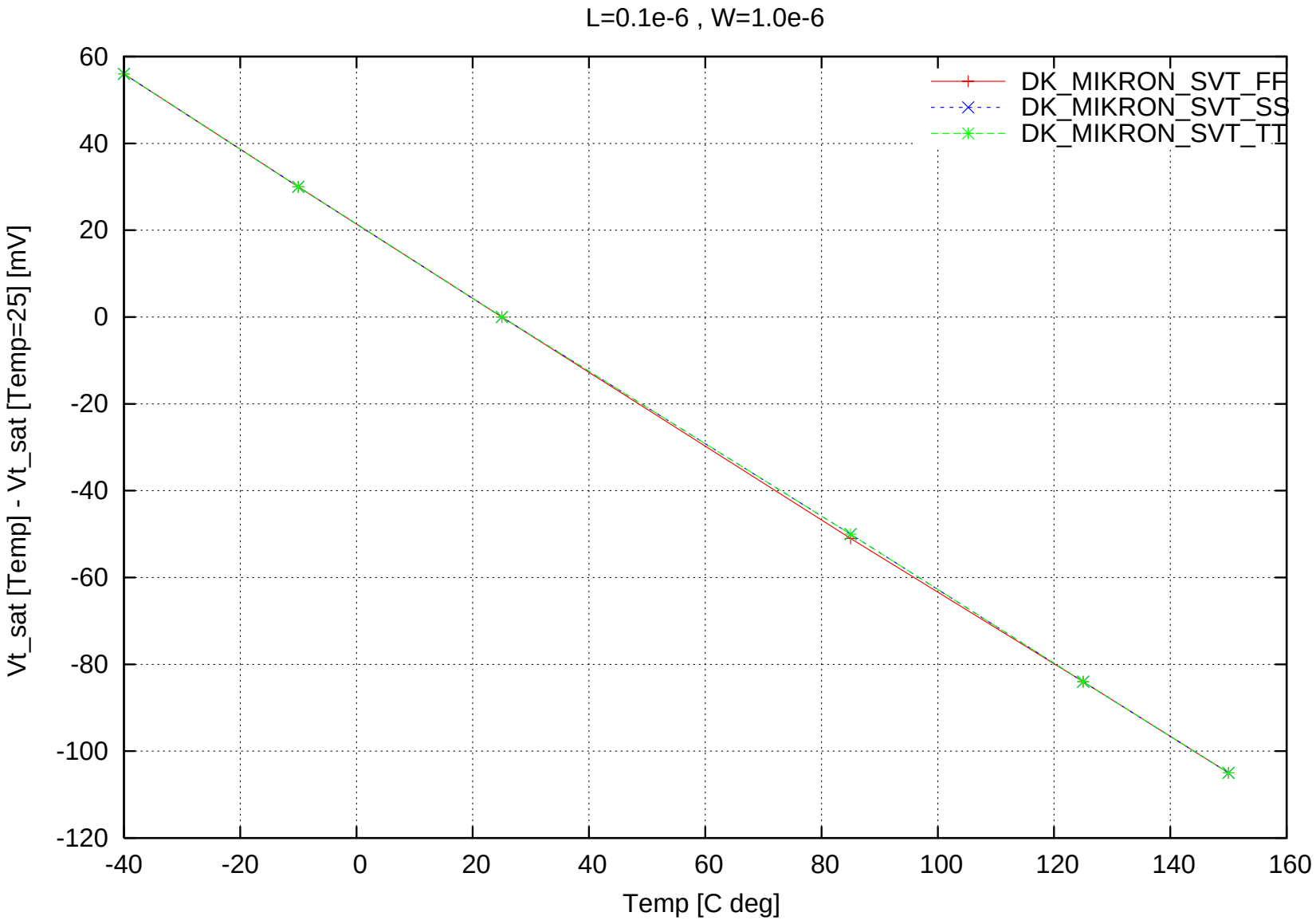
psvt Ilin [Temp] / Ilin [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



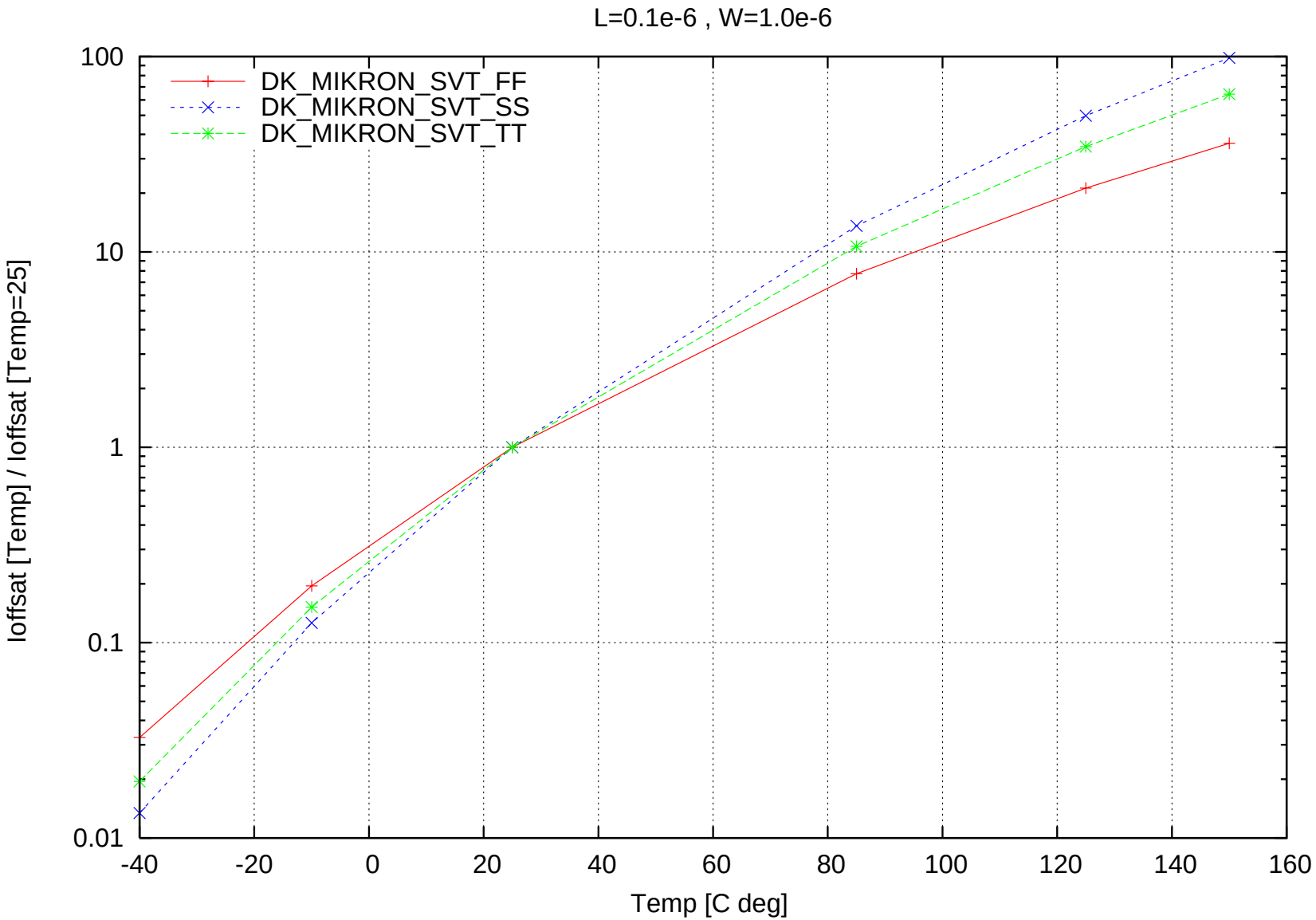
psvt Vt_lin [Temp] - Vt_lin [Temp=25] [mV] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



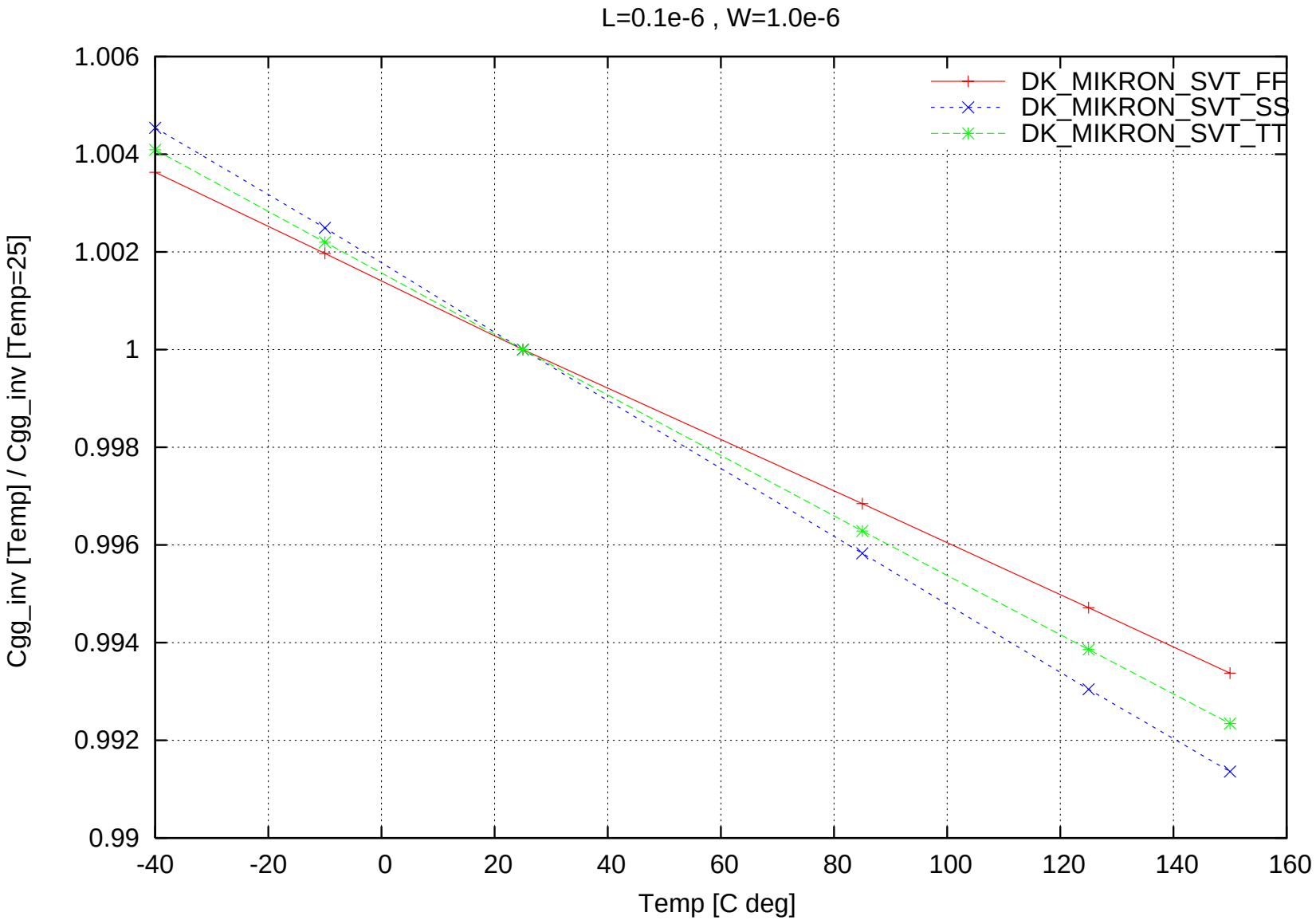
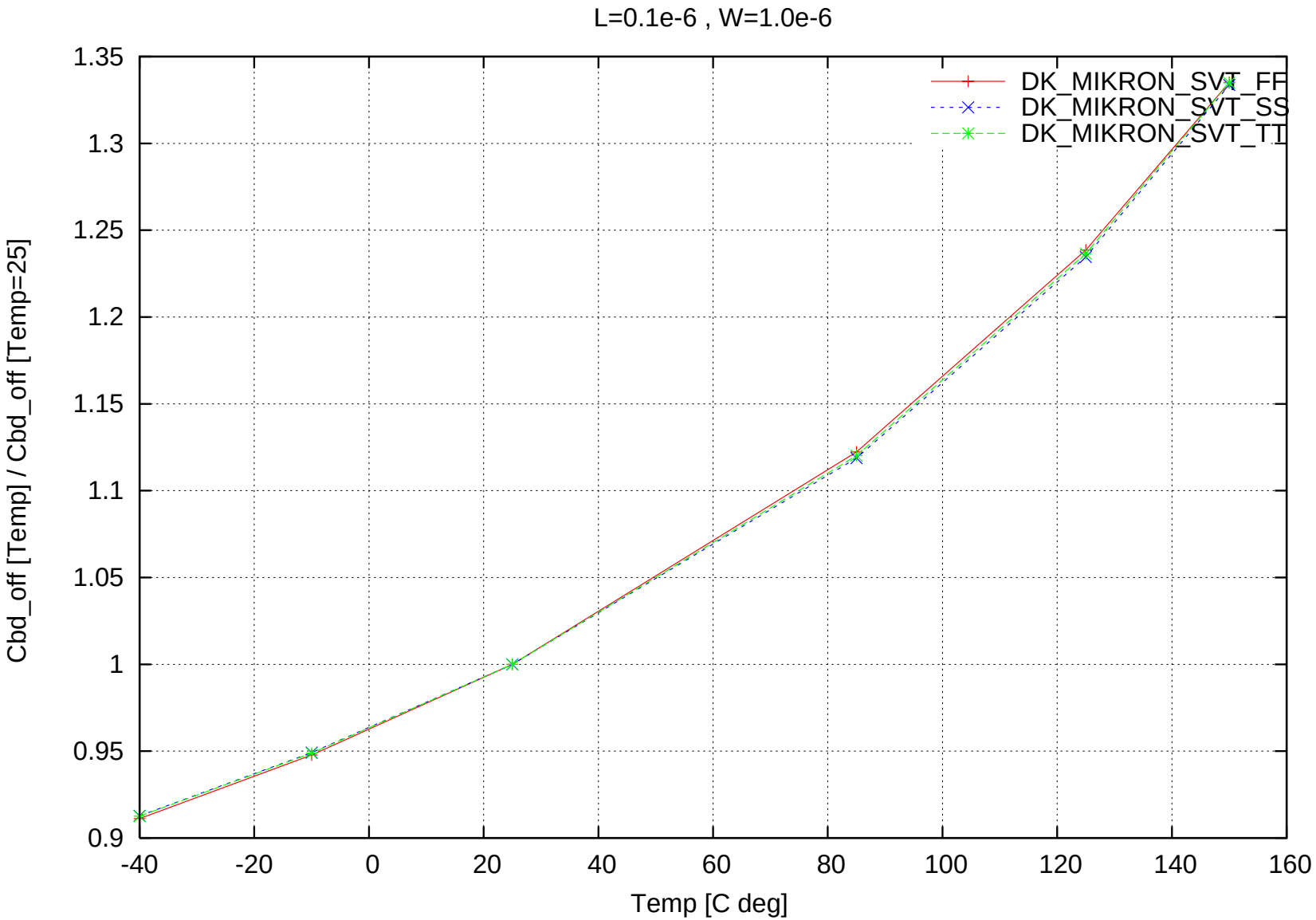
psvt Vt_sat [Temp] - Vt_sat [Temp=25] [mV] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



psvt Ioffsat [Temp] / Ioffsat [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



psvt Cgg_inv [Temp] / Cgg_inv [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6



psvt Cbd_off [Temp] / Cbd_off [Temp=25] vs. Temp [C deg] , L=0.1e-6 , W=1.0e-6