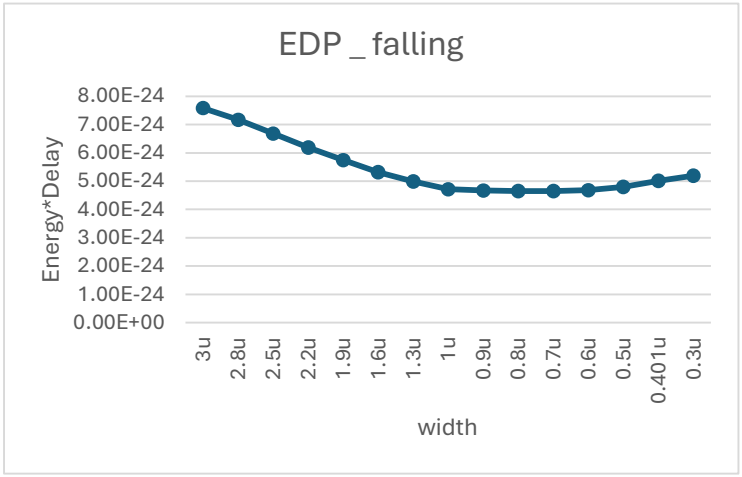
Efficient MSFF: falling

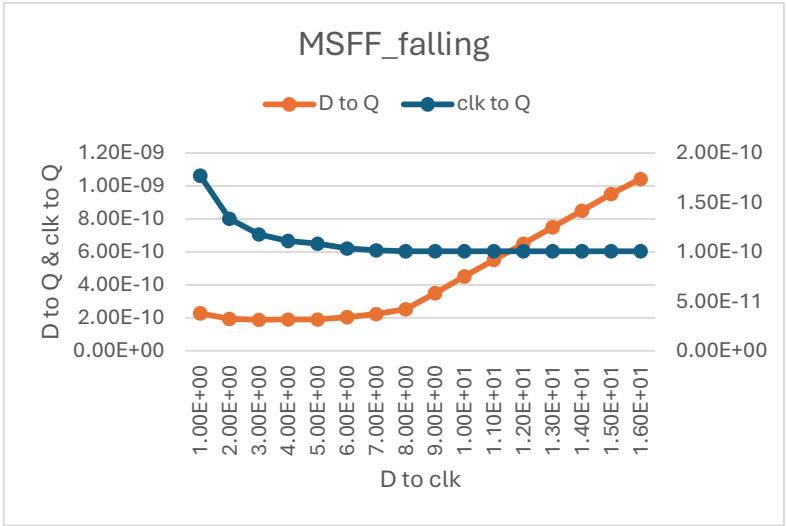
Dvalue	D to clk	clk to q	delay	power	width	Energy	EDP(PDD)
1.873n	7.70E-11	7.86E-11	1.56E-10	3.13E-04	3u	4.87E-14	7.59E-24
1.8737n	7.63E-11	7.93E-11	1.56E-10	2.96E-04	2.8u	4.61E-14	7.17E-24
1.874n	7.60E-11	7.60E-11	1.57E-10	2.71E-04	2.5u	4.25E-14	6.68E-24
1.8746n	7.54E-11	8.34E-11	1.59E-10	2.46E-04	2.2u	3.90E-14	6.20E-24
1.875n	7.50E-11	8.63E-11	1.61E-10	2.21E-04	1.9u	3.56E-14	5.74E-24
1.875n	7.50E-11	9.00E-11	1.65E-10	1.96E-04	1.6u	3.23E-14	5.32E-24
1.874n	7.60E-11	9.49E-11	1.71E-10	1.71E-04	1.3u	2.92E-14	4.99E-24
1.873n	7.70E-11	1.03E-10	1.80E-10	1.46E-04	1u	2.62E-14	4.72E-24
1.872n	7.80E-11	1.06E-10	1.84E-10	1.38E-04	0.9u	2.54E-14	4.68E-24
1.871n	7.90E-11	1.10E-10	1.89E-10	1.30E-04	0.8u	2.45E-14	4.65E-24
1.87n	8.00E-11	1.16E-10	1.96E-10	1.21E-04	0.7u	2.38E-14	4.65E-24
1.869n	8.10E-11	1.23E-10	2.04E-10	1.13E-04	0.6u	2.30E-14	4.69E-24
1.868n	8.20E-11	1.32E-10	2.14E-10	1.05E-04	0.5u	2.24E-14	4.80E-24
1.866n	8.40E-11	1.44E-10	2.28E-10	9.68E-05	0.401u	2.20E-14	5.02E-24
1.864n	8.60E-11	1.63E-10	2.42E-10	8.86E-05	0.3u	2.14E-14	5.19E-24

EDP falling :

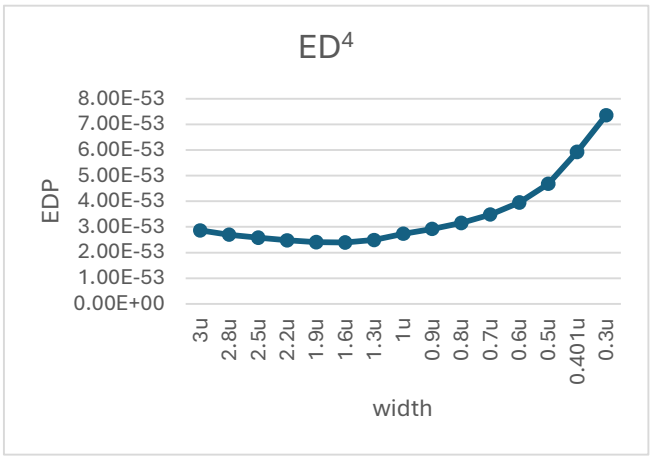


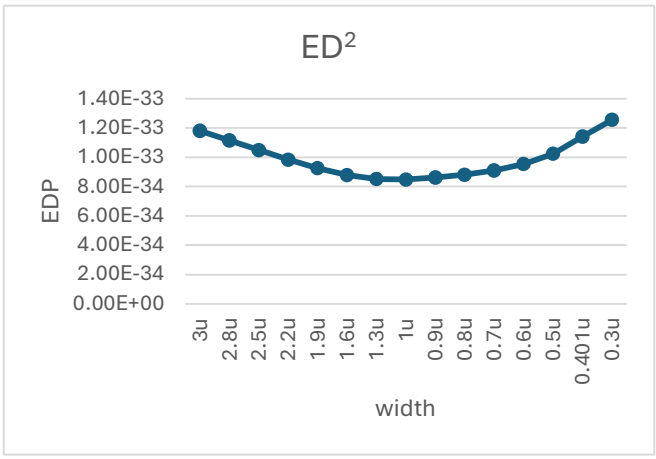
Setup time characterization: falling (setup time : 111ps (10% rise of clk to q))

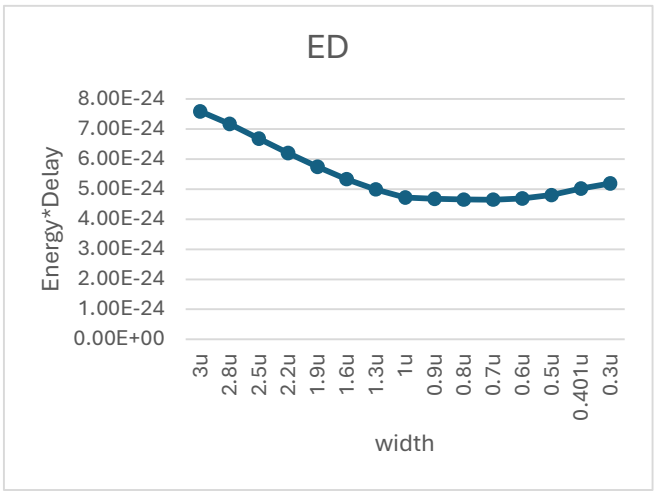
D value	D to clk	clk to Q	D to Q
1.9n	5.00E-11	1.77E-10	2.27E-10
1.89n	6.00E-11	1.34E-10	1.94E-10
1.88n	7.00E-11	1.18E-10	1.88E-10
1.872n	7.80E-11	**1.11E-10**	1.89E-10
1.87n	8.00E-11	1.08E-10	1.90E-10
1.85n	1.00E-10	1.04E-10	2.04E-10
1.83n	1.20E-10	1.02E-10	2.22E-10
1.8n	1.50E-10	1.01E-10	2.51E-10
1.7n	2.50E-10	1.01E-10	3.51E-10
1.6n	3.50E-10	1.01E-10	4.51E-10
1.5n	4.50E-10	1.01E-10	5.51E-10
1.4n	5.50E-10	1.01E-10	6.51E-10
1.3n	6.50E-10	1.01E-10	7.51E-10
1.2n	7.50E-10	1.01E-10	8.51E-10
1.1n	8.50E-10	1.01E-10	9.51E-10
1n	9.50E-10	1.01E-10	1.04E-09

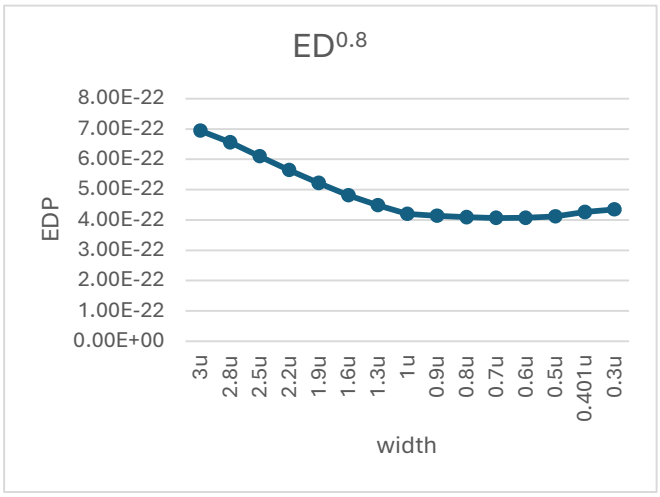


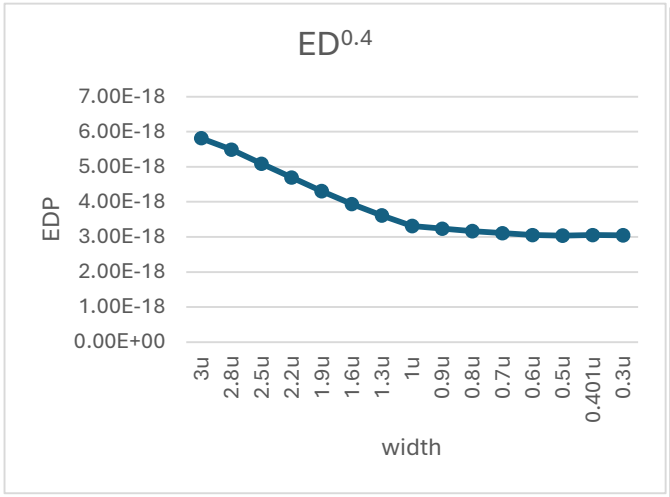
EDP plots : falling

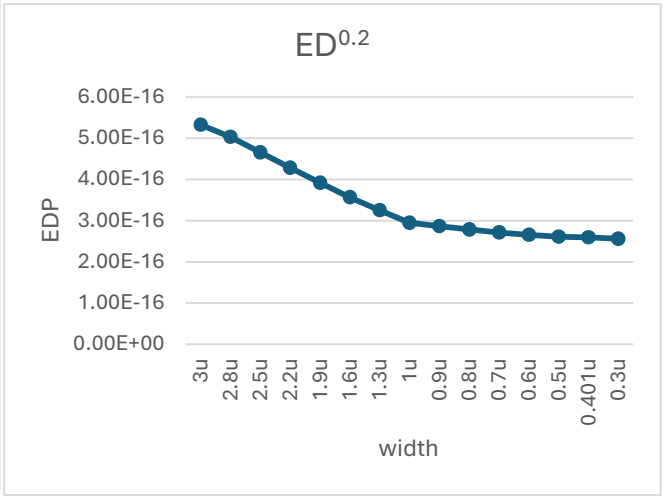






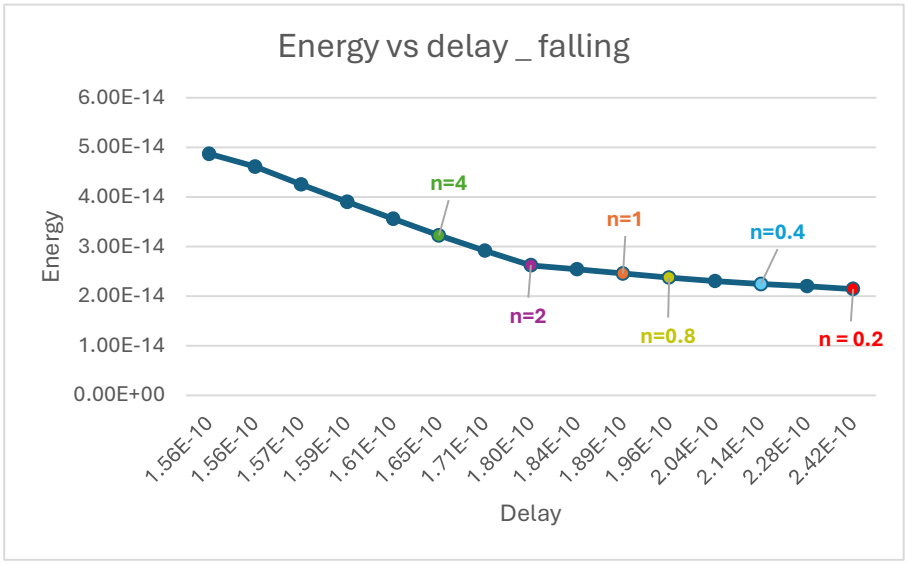






Energy vs Delay: falling

delay	power	width	Energy	EDP(PDD)	ED4	ED2	ED0.8	ED0.4	ED0.2
1.56E-10	3.13E-04	3u	4.87E-14	7.59E-24	2.86E-53	1.18E-33	6.94E-22	5.82E-18	5.32E-16
1.56E-10	2.96E-04	2.8u	4.61E-14	7.17E-24	2.70E-53	1.12E-33	6.56E-22	5.50E-18	5.03E-16
1.57E-10	2.71E-04	2.5u	4.25E-14	6.68E-24	2.59E-53	1.05E-33	6.10E-22	5.09E-18	4.65E-16
1.59E-10	2.46E-04	2.2u	3.90E-14	6.20E-24	2.48E-53	9.84E-34	5.65E-22	4.69E-18	4.28E-16
1.61E-10	2.21E-04	1.9u	3.56E-14	5.74E-24	2.41E-53	9.27E-34	5.22E-22	4.31E-18	3.92E-16
1.65E-10	1.96E-04	1.6u	3.23E-14	5.32E-24	2.39E-53	8.79E-34	4.82E-22	3.94E-18	3.57E-16
1.71E-10	1.71E-04	1.3u	2.92E-14	4.99E-24	2.49E-53	8.53E-34	4.48E-22	3.62E-18	3.25E-16
1.80E-10	1.46E-04	1u	2.62E-14	4.72E-24	2.74E-53	8.48E-34	4.19E-22	3.32E-18	2.95E-16
1.84E-10	1.38E-04	0.9u	2.54E-14	4.68E-24	2.92E-53	8.62E-34	4.14E-22	3.24E-18	2.87E-16
1.89E-10	**1.30E-04**	**0.8u**	**2.45E-14**	4.65E-24	3.16E-53	8.80E-34	4.09E-22	3.17E-18	2.79E-16
1.96E-10	1.21E-04	0.7u	2.38E-14	4.65E-24	3.48E-53	9.10E-34	4.06E-22	3.11E-18	2.72E-16
2.04E-10	1.13E-04	0.6u	2.30E-14	4.69E-24	3.95E-53	9.54E-34	4.07E-22	3.06E-18	2.66E-16
2.14E-10	1.05E-04	0.5u	2.24E-14	4.80E-24	4.69E-53	1.03E-33	4.12E-22	3.04E-18	2.61E-16
2.28E-10	9.68E-05	0.401u	2.20E-14	5.02E-24	5.92E-53	1.14E-33	4.26E-22	3.06E-18	2.60E-16
2.42E-10	8.86E-05	0.3u	2.14E-14	5.19E-24	7.36E-53	1.26E-33	4.35E-22	3.05E-18	**2.56E-16**

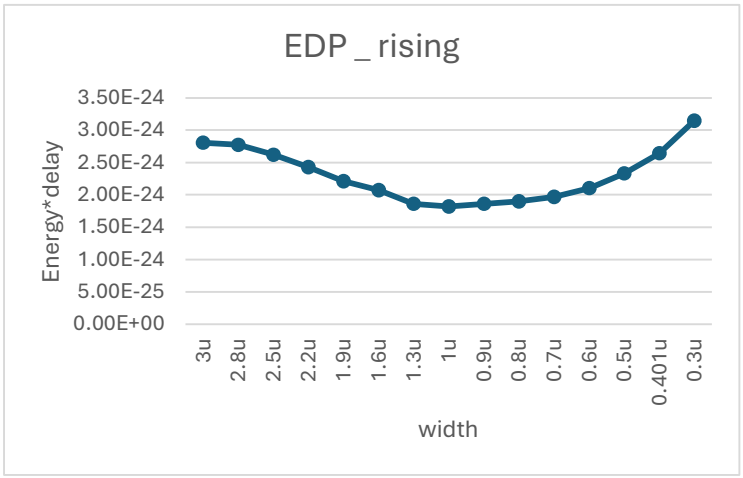


ED^4	ED^2	ED	$ED^{0.8}$	$ED^{0.4}$	$ED^{0.2}$

Rising:

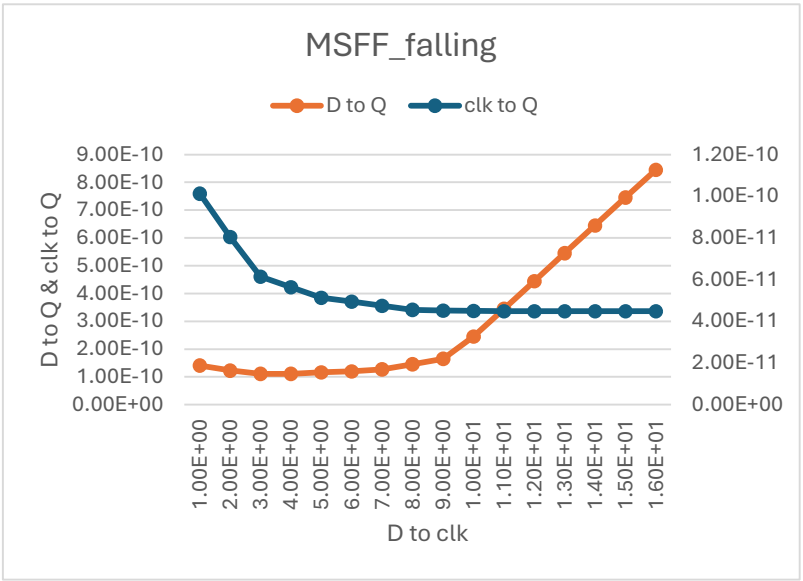
Dvalue	D to clk	clk to q	delay	power	width	Energy	EDP(PDD)
1.932n	6.80E-11	3.34E-11	1.01E-10	2.73E-04	3u	2.77E-14	2.80E-24
1.932n	7.00E-11	3.36E-11	1.04E-10	2.58E-04	2.8u	2.68E-14	2.77E-24
1.928n	7.20E-11	3.41E-11	1.05E-10	2.37E-04	2.5u	2.49E-14	2.62E-24
1.928n	7.20E-11	3.53E-11	1.06E-10	2.15E-04	2.2u	2.29E-14	2.43E-24
1.931n	6.90E-11	3.71E-11	1.07E-10	1.93E-04	1.9u	2.07E-14	2.21E-24
1.934n	6.60E-11	3.99E-11	1.10E-10	1.71E-04	1.6u	1.88E-14	2.07E-24
1.931n	6.90E-11	4.29E-11	1.12E-10	1.49E-04	1.3u	1.67E-14	1.86E-24
1.929n	7.10E-11	4.92E-11	1.20E-10	1.26E-04	1u	1.51E-14	1.82E-24
1.927n	7.30E-11	5.24E-11	1.25E-10	1.18E-04	0.9u	1.48E-14	1.86E-24
1.926n	7.40E-11	5.69E-11	1.31E-10	1.11E-04	0.8u	1.45E-14	1.90E-24
1.925n	7.50E-11	6.31E-11	1.38E-10	1.03E-04	0.7u	1.43E-14	1.97E-24
1.923n	7.70E-11	7.13E-11	1.48E-10	9.58E-05	0.6u	1.42E-14	2.11E-24
1.92n	8.00E-11	8.26E-11	1.63E-10	8.82E-05	0.5u	1.43E-14	2.33E-24
1.918n	8.20E-11	9.91E-11	1.81E-10	8.07E-05	0.401u	1.46E-14	2.65E-24
1.916n	8.40E-11	1.24E-10	2.08E-10	7.31E-05	0.3u	1.52E-14	3.15E-24

EDP rising:

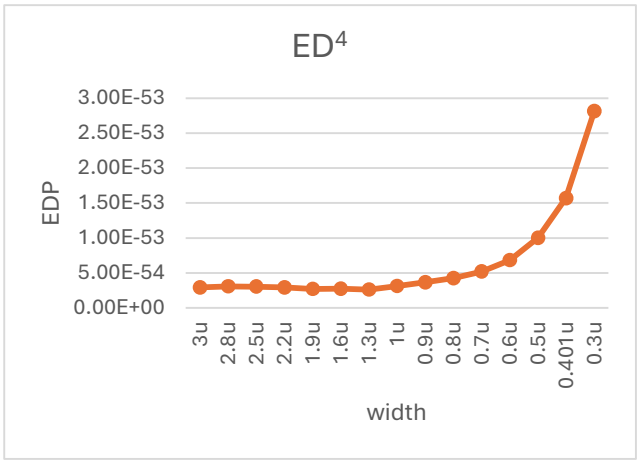


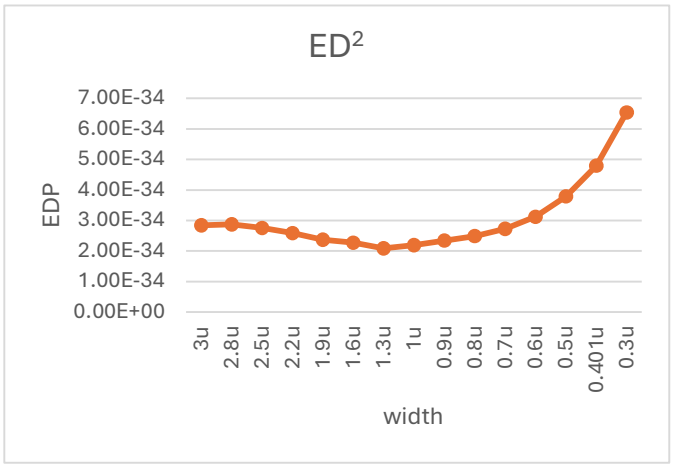
Setup time characterization: rising (setup time : 49.5 ps (10% rise of clk to q))

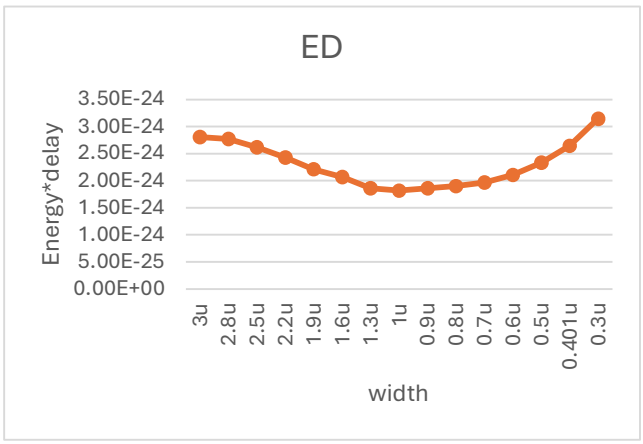
D value	D to clk	clk to Q	D to Q
1.96n	4.00E-11	1.01E-10	1.41E-10
1.957n	4.30E-11	8.04E-11	1.23E-10
1.95n	5.00E-11	6.15E-11	1.11E-10
1.945n	5.50E-11	5.64E-11	1.11E-10
1.935n	6.50E-11	5.13E-11	1.16E-10
1.93n	7.00E-11	**4.95E-11**	1.19E-10
1.92n	8.00E-11	4.74E-11	1.27E-10
1.9n	1.00E-10	4.56E-11	1.46E-10
1.88n	1.20E-10	4.51E-11	1.65E-10
1.8n	2.00E-10	4.49E-11	2.45E-10
1.7n	3.00E-10	4.49E-11	3.45E-10
1.6n	4.00E-10	4.49E-11	4.45E-10
1.5n	5.00E-10	4.49E-11	5.45E-10
1.4n	6.00E-10	4.49E-11	6.45E-10
1.3n	7.00E-10	4.49E-11	7.45E-10
1.2n	8.00E-10	4.49E-11	8.45E-10

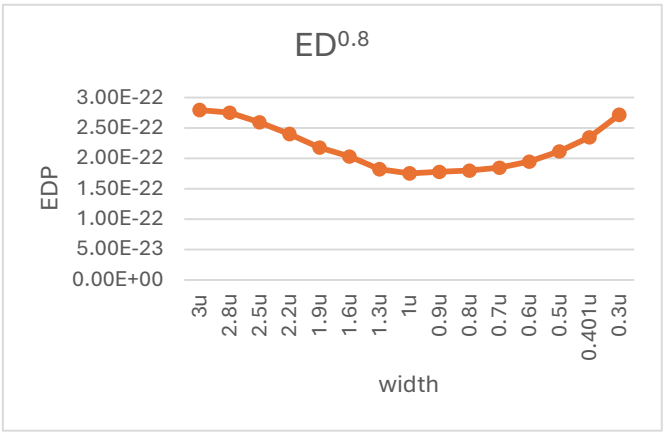


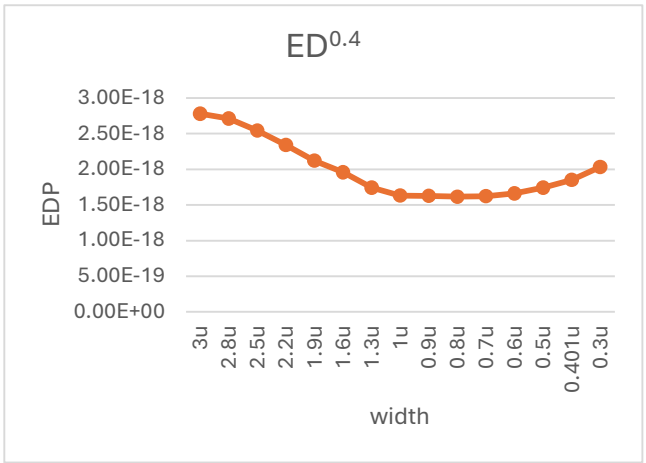
EDP plots :

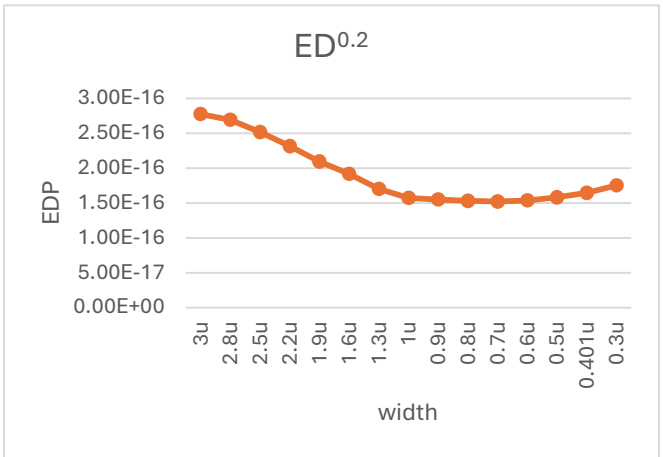

ED4
EDP
3.00E-53
2.50E-53
2.00E-53
1.50E-53
1.00E-53
5.00E-54
0.00E+00
3u
2.8u
2.5u
2.2u
1.9u
1.6u
1.3u
1u
0.9u
0.8u
0.7u
0.6u
0.5u
0.401u
0.3u
width


ED2
EDP
7.00E-34
6.00E-34
5.00E-34
4.00E-34
3.00E-34
2.00E-34
1.00E-34
0.00E+00
3u
2.8u
2.5u
2.2u
1.9u
1.6u
1.3u
1u
0.9u
0.8u
0.7u
0.6u
0.5u
0.401u
0.3u
width


ED
Energy*delay
3.50E-24
3.00E-24
2.50E-24
2.00E-24
1.50E-24
1.00E-24
5.00E-25
0.00E+00
3u
2.8u
2.5u
2.2u
1.9u
1.6u
1.3u
1u
0.9u
0.8u
0.7u
0.6u
0.5u
0.401u
0.3u
width

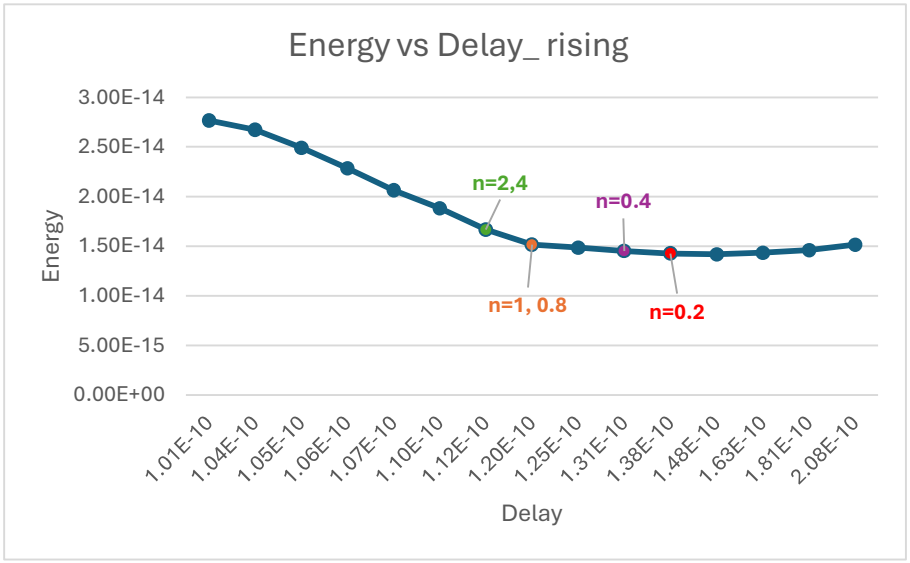

ED0.8
EDP
3.00E-22
2.50E-22
2.00E-22
1.50E-22
1.00E-22
5.00E-23
0.00E+00
3u
2.8u
2.5u
2.2u
1.9u
1.6u
1.3u
1u
0.9u
0.8u
0.7u
0.6u
0.5u
0.401u
0.3u
width


ED0.4
EDP
3.00E-18
2.50E-18
2.00E-18
1.50E-18
1.00E-18
5.00E-19
0.00E+00
3u
2.8u
2.5u
2.2u
1.9u
1.6u
1.3u
1u
0.9u
0.8u
0.7u
0.6u
0.5u
0.401u
0.3u
width


ED0.2
EDP
3.00E-16
2.50E-16
2.00E-16
1.50E-16
1.00E-16
5.00E-17
0.00E+00
3u
2.8u
2.5u
2.2u
1.9u
1.6u
1.3u
1u
0.9u
0.8u
0.7u
0.6u
0.5u
0.401u
0.3u
width

Energy vs Delay : rising

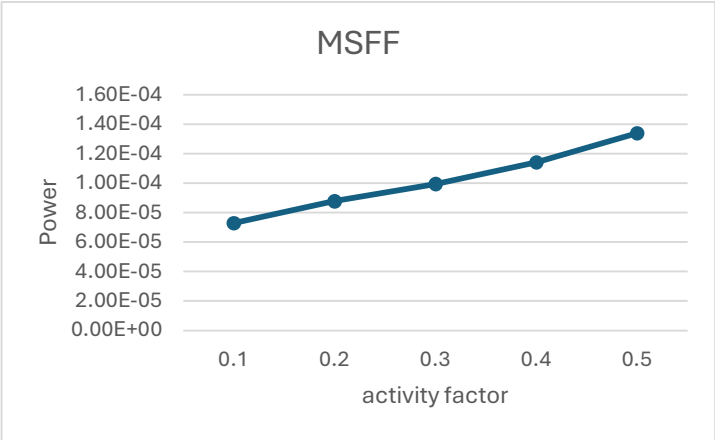
delay	power	width	Energy	EDP(PDD)	ED4	ED2	ED0.8	ED0.4	ED0.2
1.01E-10	2.73E-04	3u	2.77E-14	2.80E-24	2.92E-54	2.84E-34	2.80E-22	2.78E-18	2.77E-16
1.04E-10	2.58E-04	2.8u	2.68E-14	2.77E-24	3.08E-54	2.87E-34	2.75E-22	2.71E-18	2.69E-16
1.05E-10	2.37E-04	2.5u	2.49E-14	2.62E-24	3.04E-54	2.75E-34	2.59E-22	2.54E-18	2.52E-16
1.06E-10	2.15E-04	2.2u	2.29E-14	2.43E-24	2.92E-54	2.58E-34	2.40E-22	2.34E-18	2.31E-16
1.07E-10	1.93E-04	1.9u	2.07E-14	2.21E-24	2.71E-54	2.37E-34	2.18E-22	2.12E-18	2.09E-16
1.10E-10	1.71E-04	1.6u	1.88E-14	2.07E-24	2.74E-54	2.27E-34	2.03E-22	1.96E-18	1.92E-16
1.12E-10	1.49E-04	1.3u	1.67E-14	1.86E-24	2.61E-54	2.09E-34	1.82E-22	1.74E-18	1.70E-16
1.20E-10	**1.26E-04**	**1u**	**1.51E-14**	1.82E-24	3.16E-54	2.19E-34	1.75E-22	1.63E-18	1.57E-16
1.25E-10	1.18E-04	0.9u	1.48E-14	1.86E-24	3.67E-54	2.34E-34	1.78E-22	1.63E-18	1.55E-16
1.31E-10	1.11E-04	0.8u	1.45E-14	1.90E-24	4.27E-54	2.49E-34	1.80E-22	1.62E-18	1.53E-16
1.38E-10	1.03E-04	0.7u	1.43E-14	1.97E-24	5.19E-54	2.72E-34	1.85E-22	1.62E-18	1.52E-16
1.48E-10	9.58E-05	0.6u	1.42E-14	2.11E-24	6.86E-54	3.12E-34	1.95E-22	1.66E-18	1.54E-16
1.63E-10	8.82E-05	0.5u	1.43E-14	2.33E-24	1.00E-53	3.79E-34	2.12E-22	1.74E-18	1.58E-16
1.81E-10	8.07E-05	0.401u	1.46E-14	2.65E-24	1.57E-53	4.79E-34	2.35E-22	1.85E-18	1.65E-16
2.08E-10	7.31E-05	0.3u	1.52E-14	3.15E-24	2.81E-53	6.53E-34	2.72E-22	2.03E-18	1.76E-16



ED^4, ED^2	ED, $ED^{0.8}$	$ED^{0.4}$	$ED^{0.2}$

Power vs Activity factor :

MSFF	
activity factor	**power**
0.1	7.30E-05
0.2	8.79E-05
0.3	9.94E-05
0.4	1.14E-04
0.5	1.34E-04
slope	1.52E-04



MSFF power:

MSFF	
clk, data	**Static power**
0,0	3.80E-08
0,1	5.13E-08
1,0	7.06E-08
1,1	7.26E-08
Avg =	5.81E-08

clk	**data switching power**
0	4.40E-05
1	1.24E-05
Avg=	2.82E-05
Rswitching	1.01E-04

data	**clk power**
0	5.57E-05
1	5.49E-05
Avg=	5.53E-05

The efficient circuit of MSFF is in falling transition, because the worst case is in falling transition in terms of EDP.