

The number of pixels and the FFOV are limited by the laser repetition rate, i.e., how many laser pulses fit in a scanned line.

For a 80 MHz laser and 8 kHz scanner, there are $80 \text{ MHz} / (2 \cdot 8 \text{ kHz}) = 5000$ pulses. For example, if we have 10 pulses per pixel, then there could be 500 pixels max

```

μm = 10-6;
μs = 10-6;
ms = 10-3;
ns = 10-9;
mm = 10-3;
kHz = 103;
Tline = 63.05 μs; (*Time per scanned line*)
Tlaser = 12.5 ns; (*Laser pulse repetition period*)
tFPGA = 6.25 ns; (*FPGA clock*)
Δx = 0.5 μm; (*Spatial resolution*)

MaxPulsesPerPixel = 13;
dwell = MaxPulsesPerPixel * Tlaser;
NpixFFOV = 300; (*Effective pixel number. Even number*)
γ = Sin[ $\frac{\pi}{2} \frac{NpixFFOV * dwell}{Tline}$ ]; (*Spatial fill factor*)
FFOV = NpixFFOV * Δx; (*Full field of view of the microscope*)
FullScan = FFOV / γ; (*Full scan of the RS = distance between turning points*)

Grid[{{"Max pulses per pixel", 13}, {"Pixel dwell time (ns)", dwell/ns},
      {"Number of pixels", NpixFFOV}, {"Fill factor", γ},
      {"Full scan (μm)", FullScan/μm}, {"Full FOV (μm)", FFOV/μm}}, Frame → All]

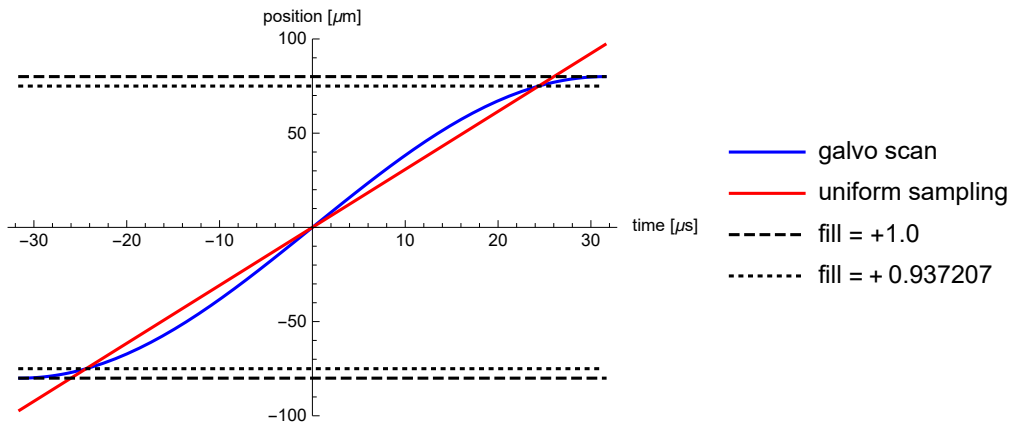
```

Max pulses per pixel	13
Pixel dwell time (ns)	162.5
Number of pixels	300
Fill factor	0.937207
Full scan (μm)	160.05
Full FOV (μm)	150.

```

RPosition[t_] :=  $\frac{\text{FullScan}}{2} \sin\left[\frac{\pi}{T_{\text{line}}} t\right]$  (*Position of the resonant scanner vs time*)
time[x_] :=  $\frac{T_{\text{line}}}{\pi} \text{ArcSin}\left[\frac{2}{\text{FullScan}} x\right]$  (*Convert from spatial coordinate to time*)
Plot[{RPosition[t  $\mu$ s] /  $\mu$ m,  $\frac{\text{FFOV}/2}{\text{time}[\text{FFOV}/2]} t \frac{\mu\text{s}}{\mu\text{m}}$ , {FullScan/2, -FullScan/2} /  $\mu$ m,
      {-FFOV/2, FFOV/2} /  $\mu$ m}, {t, -Tline/2 /  $\mu$ s, Tline/2 /  $\mu$ s},
      PlotRange  $\rightarrow$  {-100, 100}, PlotStyle  $\rightarrow$  {Blue, Red, {Dashed, Black}, {Dotted, Black}},
      AxesLabel  $\rightarrow$  {"time [ $\mu$ s]", "position [ $\mu$ m]"},
      PlotLegends  $\rightarrow$  {"galvo scan", "uniform sampling", "fill = +1.0", "fill = " +  $\gamma$ }]

```



```

DiscreteTime[pix_] := pix * dwell; (*Time discretization*)
DiscretePosition[pix_] := RPosition[DiscreteTime[pix]]
(*Spatial discretization mapped from the time discretization*)

(*Tabulate the position vs time*)
NpixFullScan = Round[NpixFFOV / (2  $\gamma$ )] * 2;
(*Full pixel number. Divide and multiply by 2 to get an even number*)
header = {"pixel", "Time [ $\mu$ s]", "Position [ $\mu$ m]"};
TableForm[Prepend[Table[{pix, DiscreteTime[pix] /  $\mu$ s, DiscretePosition[pix] /  $\mu$ m},
      {pix, NpixFullScan/2, 0, -1}], header]]

```

pixel	Time [μ s]	Position [μ m]
160	26.	77.0117
159	25.8375	76.8331
158	25.675	76.6494
157	25.5125	76.4606
156	25.35	76.2669
155	25.1875	76.0682
154	25.025	75.8645
153	24.8625	75.6558
152	24.7	75.4421
151	24.5375	75.2235
150	24.375	75.
149	24.2125	74.7716
148	24.05	74.5382
147	23.8875	74.3
146	23.725	74.0569
145	23.5625	73.8089

144	23.4	73.5561
143	23.2375	73.2985
142	23.075	73.0361
141	22.9125	72.7688
140	22.75	72.4969
139	22.5875	72.2201
138	22.425	71.9386
137	22.2625	71.6525
136	22.1	71.3616
135	21.9375	71.066
134	21.775	70.7658
133	21.6125	70.4609
132	21.45	70.1514
131	21.2875	69.8373
130	21.125	69.5187
129	20.9625	69.1955
128	20.8	68.8677
127	20.6375	68.5354
126	20.475	68.1987
125	20.3125	67.8574
124	20.15	67.5118
123	19.9875	67.1617
122	19.825	66.8071
121	19.6625	66.4483
120	19.5	66.085
119	19.3375	65.7174
118	19.175	65.3455
117	19.0125	64.9694
116	18.85	64.5889
115	18.6875	64.2043
114	18.525	63.8154
113	18.3625	63.4223
112	18.2	63.0251
111	18.0375	62.6238
110	17.875	62.2183
109	17.7125	61.8088
108	17.55	61.3952
107	17.3875	60.9776
106	17.225	60.556
105	17.0625	60.1304
104	16.9	59.7009
103	16.7375	59.2674
102	16.575	58.8301
101	16.4125	58.3889
100	16.25	57.9439
99	16.0875	57.4951
98	15.925	57.0426
97	15.7625	56.5862
96	15.6	56.1262
95	15.4375	55.6625
94	15.275	55.1952
93	15.1125	54.7242
92	14.95	54.2496
91	14.7875	53.7715
90	14.625	53.2899
89	14.4625	52.8048
88	14.3	52.3162
87	14.1375	51.8241
86	13.975	51.3287
85	13.8125	50.8299

84	13.65	50.3278
83	13.4875	49.8224
82	13.325	49.3137
81	13.1625	48.8018
80	13.	48.2867
79	12.8375	47.7684
78	12.675	47.247
77	12.5125	46.7225
76	12.35	46.1949
75	12.1875	45.6643
74	12.025	45.1307
73	11.8625	44.5941
72	11.7	44.0546
71	11.5375	43.5123
70	11.375	42.9671
69	11.2125	42.419
68	11.05	41.8682
67	10.8875	41.3146
66	10.725	40.7584
65	10.5625	40.1994
64	10.4	39.6378
63	10.2375	39.0737
62	10.075	38.5069
61	9.9125	37.9377
60	9.75	37.3659
59	9.5875	36.7917
58	9.425	36.2151
57	9.2625	35.6361
56	9.1	35.0548
55	8.9375	34.4712
54	8.775	33.8853
53	8.6125	33.2972
52	8.45	32.7069
51	8.2875	32.1145
50	8.125	31.5199
49	7.9625	30.9233
48	7.8	30.3247
47	7.6375	29.7241
46	7.475	29.1215
45	7.3125	28.517
44	7.15	27.9107
43	6.9875	27.3025
42	6.825	26.6925
41	6.6625	26.0808
40	6.5	25.4674
39	6.3375	24.8523
38	6.175	24.2356
37	6.0125	23.6173
36	5.85	22.9974
35	5.6875	22.376
34	5.525	21.7532
33	5.3625	21.1289
32	5.2	20.5033
31	5.0375	19.8763
30	4.875	19.248
29	4.7125	18.6185
28	4.55	17.9877
27	4.3875	17.3557
26	4.225	16.7226
25	4.0625	16.0884

24	3.9	15.4532
23	3.7375	14.8169
22	3.575	14.1797
21	3.4125	13.5416
20	3.25	12.9025
19	3.0875	12.2626
18	2.925	11.6219
17	2.7625	10.9805
16	2.6	10.3383
15	2.4375	9.69543
14	2.275	9.05194
13	2.1125	8.40785
12	1.95	7.76322
11	1.7875	7.11807
10	1.625	6.47246
9	1.4625	5.82642
8	1.3	5.18001
7	1.1375	4.53325
6	0.975	3.88619
5	0.8125	3.23888
4	0.65	2.59136
3	0.4875	1.94367
2	0.325	1.29585
1	0.1625	0.647947
0	0.	0.