

Position Calibration Targets

English and Metric Measure

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1 Calibration Grid[calibrationgrid]

To aid in determining the pointing accuracy of a Pan/Tilt/Dome a set of targets with calibrated 0.1° and 0.01° marks in pan and tilt have been developed for use at different distances from the unit being tested.

The method of calculating the angular distance required for 0.1° movement at various distances away from the camera is:

$$\pi = 3.1415926$$

For English Measure:

$$c_{ft} = 2 \times \pi \times r_{ft}$$

$$a_{in} = (c_{ft} \times 12) / (360 \times 10)$$

For Metric Measure:

$$c_m = 2 \times \pi \times r_m$$

$$a_m = c_m / (360 \times 10)$$

Where:

- a_{in} = Arc of 0.1° width in inches.
- a_m = Arc of 0.1° width in meters.
- c_{ft} = Circumference of a circle in feet.
- c_m = Circumference of a circle in meters.
- r_{ft} = Radius of a circle in feet.
- r_m = Radius of a circle in meters.
- 2 = Factor between diameter and radius of a circle.
- 10 = Conversion factor from whole degrees to tenths of a degree.
- 12 = Conversion factor from feet to inches.
- 360 = Degrees in a circle.

For example at 48 feet from the camera, 0.1° of angular distance is 1.01 inch long. (Or 1.005300032 inch if more accuracy is needed.)

And at 3.5 meters from the camera, 0.1° of angular distance is .0061 meters (or .61 cm) long. (Or 0.610866 cm, if more accuracy is needed.)

²\$Header: d:/Binder2/Targets/RCS/Targets.tex,v 1.10 2008-09-11 13:09:58-07 Hamilton Exp
Hamilton \$

1.1 How to use the targets

The included targets in this note are designed for use with English Measurements at ranges of $2 \rightarrow 11$ feet in full foot increments and from $12 \rightarrow 56$ feet in even foot increments, between the camera and the target³. For metric units the range is $1 \rightarrow 9.5$ in $\frac{1}{2}$ meter units and from $10 \rightarrow 20$ in full meter increments.

Each of the larger grids consists of a “large” and a “small” set of dots⁴. The large dots are 0.1° apart and the small dots are 0.01° apart. Each target has a central dot with the distance that the target is anticipated to be used at underneath. They also have four large sub-dots which are numbered from 1 to 4 for additional testing.

1. More than one of these may be used at any one time. I.e. there may be two places that it is reasonable to point a camera at which may be on different walls, or other convenient surface, which may be at different, or the same, distances. Thus two targets would be used for the same series of tests.
2. When selecting a target to use it should be remembered that the distance to be used is the estimated distance from the camera’s physical “pivot point”. This may or may not be the front of the lens of the camera nor may it be the “optical center” of the camera.
3. When using English Measurement units, a reasonably accurate indication of distance, it should be remembered that ceiling tiles are two feet on a side (some are two by four with a line down the middle). Over any reasonable distance any errors average out and the result is quite accurate. (Usually better than ± 1 inch.) It is unknown what the common sizes of ceiling tiles are in other locations.
4. To easily calculate distance, count full tiles and double, or quadruple, their number. (Ceiling tiles being either 2 feet by 4 feet, or 2 feet by 2 feet in size.) The result is the distance between the camera and the target.
5. When using these targets, their accuracy improves somewhat when longer distances are used. The recommended distances to use with these targets are in the 40’s of feet (40, 42, 44, 46 and 48). Or use distances greater than 10 meters. The reasons for this are that small errors in determining the exact pivot point of a PTZ become insignificant if there is an error of $\frac{1}{4}$ inch (6 mm) when the radius is over 35 feet (10 meters), but it is significant when the radius is 3 feet (1 meter).
6. If distances other than those provided in this set of foot distances are needed please let me know and I’ll generate some more targets. I am only setup to generate targets on $8\frac{1}{2}$ by 11 inch paper in portrait format and in whole foot distances. I.e. no landscape formats and no “bigger” paper. (If it is important the distances for which the targets are generated at may be changed on request.)

³Targets may be generated for other distances if needed.

⁴The smaller grids do not have the 0.01° grids because the dots are too close together and tend to make a black box with no obvious dots in it.

7. When closer distances are needed than are provided by this set of targets, use the small grids and move the entire target 10× closer. I.e. use the 40 foot target at 4 feet. When this is done the small target is correct for the closer distance.
8. Always remember that custom targets are made on request. So a target may be made for almost any reasonable distance. The only limitations are the size of the paper and the resolution of the printer⁵.
9. An accuracy of $\pm .1^\circ$ is interpreted to mean: “The unit will point to within $.1^\circ$ from where it is supposed to point. The pointing is to be within a square box that has equal length sides of $.2^\circ$ and the aiming point is to be in the center of the box. This is different than using a circle with a radius of $.1^\circ$.”

A note on the accuracy of the targets

Accuracy in the generation of the grid is controlled by the quality of the printer used to print it out and the number of times that the individual target has been reproduced.

The generated PDF file is correct, however the actual printing process sometimes introduces sizeing errors. When paper is wrapped around a drum, as it is with most laser printers, one surface is longer (one side is on the outside of the circle so its radius is slightly longer than the other side's is).

While the paper direction that is longitudinal to the cylinder is almost always “correct”. This results in dimensions in one direction being somewhat better than those in the other direction.

To get an estimate of the amount of “printing error” that has been introduced to any given target, an inch rule has been provided on each edge of the target grid. If this inch rule is checked with an accurate machinist's ruler and indication of the dimensional errors that have been introduced to the copy at hand may be estimated. For almost all uses the introduced error may be ignored.

On metric grids I have put a metric distance rule on the grids.

⁵And the attitude of the author!

d_{ft}	a_{in}	d_{ft}	a_{in}	d_{ft}	a_{in}	d_{ft}	a_{in}
2	0.041887501	34	0.712087523	66	1.382287544	98	2.052487565
4	0.083775003	36	0.753975024	68	1.424175045	100	2.094375067
6	0.125662504	38	0.795862525	70	1.466062547	102	2.136262568
8	0.167550005	40	0.837750027	72	1.507950048	104	2.178150069
10	0.209437507	42	0.879637528	74	1.549837549	106	2.220037571
12	0.251325008	44	0.921525029	76	1.591725051	108	2.261925072
14	0.293212509	46	0.963412531	78	1.633612552	110	2.303812573
16	0.335100011	48	1.005300032	80	1.675500053	112	2.345700075
18	0.376987512	50	1.047187533	82	1.717387555	114	2.387587576
20	0.418875013	52	1.089075035	84	1.759275056	116	2.429475077
22	0.460762515	54	1.130962536	86	1.801162557	118	2.471362579
24	0.502650016	56	1.172850037	88	1.843050059	120	2.513250080
26	0.544537517	58	1.214737539	90	1.884937560	122	2.555137581
28	0.586425019	60	1.256625040	92	1.926825061	124	2.597025083
30	0.628312520	62	1.298512541	94	1.968712563	126	2.638912584
32	0.670200021	64	1.340400043	96	2.010600064	128	2.680800085

Table 1: Full Table of 0.1° widths for English Measure[englishfulltable]

d_{ft}	a_{in}	d_{ft}	a_{in}	d_{ft}	a_{in}	d_{ft}	a_{in}
2	0.042	34	0.71	66	1.38	98	2.05
4	0.084	36	0.75	68	1.42	100	2.09
6	0.126	38	0.80	70	1.47	102	2.14
8	0.168	40	0.84	72	1.51	104	2.18
10	0.209	42	0.88	74	1.55	106	2.22
12	0.251	44	0.92	76	1.59	108	2.26
14	0.293	46	0.96	78	1.63	110	2.30
16	0.335	48	1.01	80	1.68	112	2.35
18	0.377	50	1.05	82	1.72	114	2.39
20	0.419	52	1.09	84	1.76	116	2.41
22	0.461	54	1.13	86	1.80	118	2.47
24	0.503	56	1.17	88	1.84	120	2.51
26	0.545	58	1.21	90	1.88	122	2.56
28	0.586	60	1.26	92	1.92	124	2.60
30	0.628	62	1.30	94	1.97	126	2.64
32	0.670	64	1.34	96	2.01	128	2.68

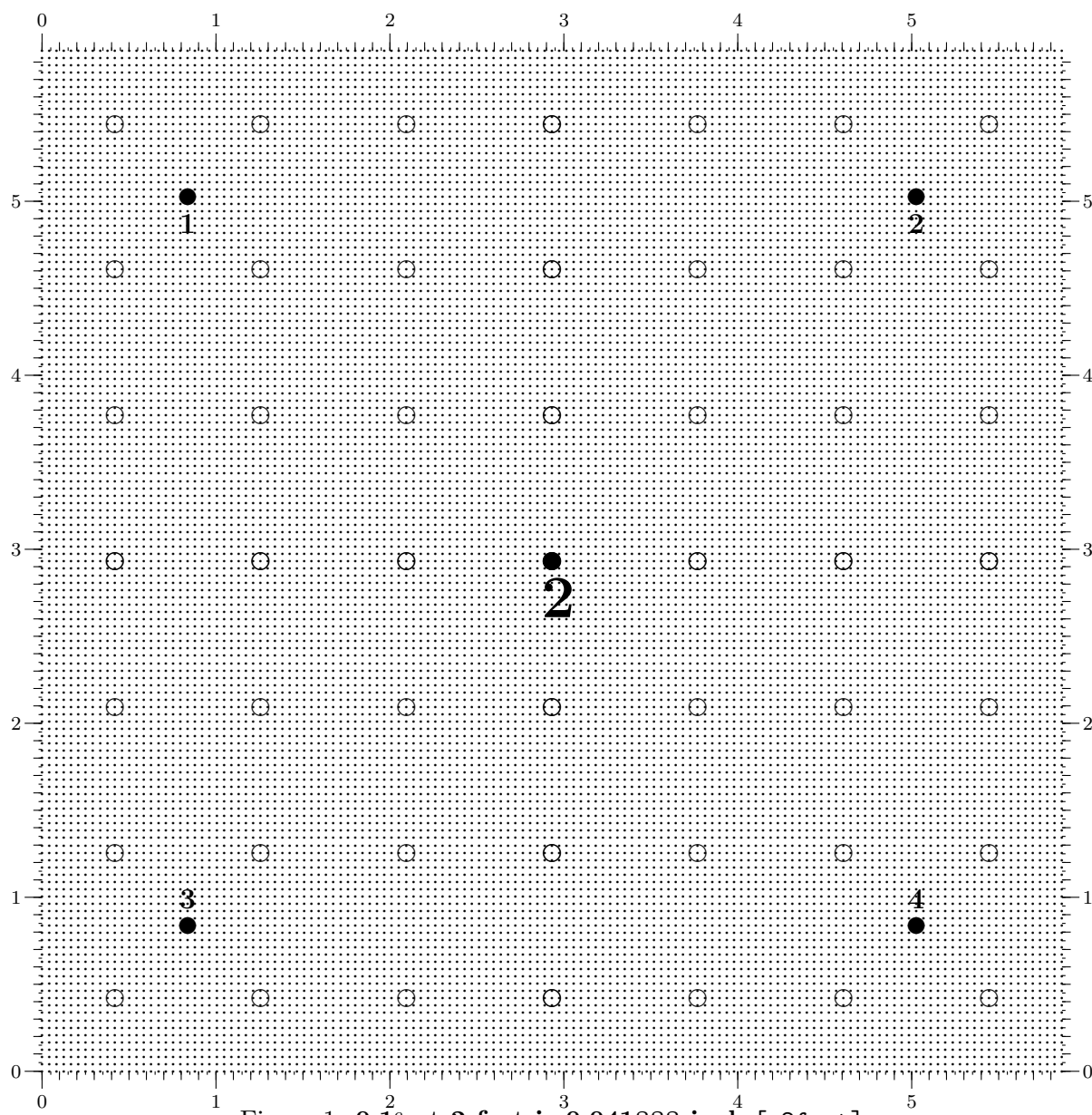
Table 2: Rounded Values of 0.1° widths for English Measure[englishroundedvalues]

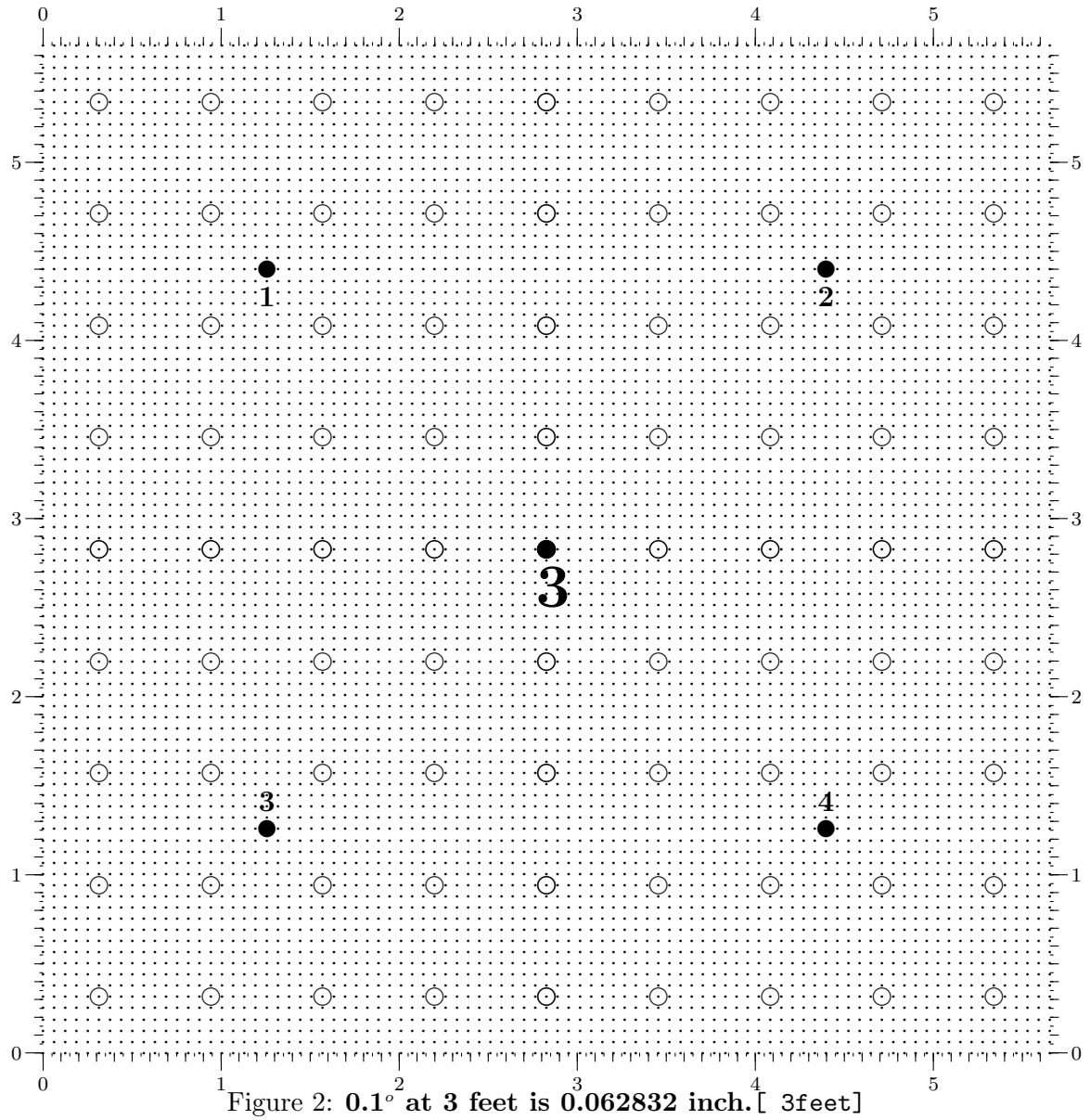
Full				Rounded			
d_m	a_{mm}	d_m	a_{mm}	d_m	a_{mm}	d_m	a_{mm}
1.0	1.745331	8.5	14.835320	1.0	1.75	8.5	14.84
1.5	2.617997	9.0	15.707980	1.5	2.62	9.0	15.71
2.0	3.490663	9.5	16.580650	2.0	3.49	9.5	16.58
2.5	4.363328	10.0	17.453310	2.5	4.36	10.0	17.45
3.0	5.235995	11.0	19.198650	3.0	5.26	11.0	19.20
3.5	6.108660	12.0	20.943980	3.5	6.11	12.0	20.94
4.0	6.981325	13.0	22.689310	4.0	6.98	13.0	22.69
4.5	7.853991	14.0	24.434640	4.5	7.85	14.0	24.43
5.0	8.726656	15.0	26.179970	5.0	8.73	15.0	26.18
5.5	9.599322	16.0	27.925300	5.5	9.60	16.0	27.93
6.0	10.471990	17.0	29.670630	6.0	10.47	17.0	29.67
6.5	11.344650	18.0	31.415960	6.5	11.34	18.0	31.41
7.0	12.217320	19.0	33.161290	7.0	12.21	19.0	33.16
7.5	13.089990	20.0	34.906630	7.5	13.90	20.0	34.91
8.0	13.962650	—	—	8.0	13.96	—	—

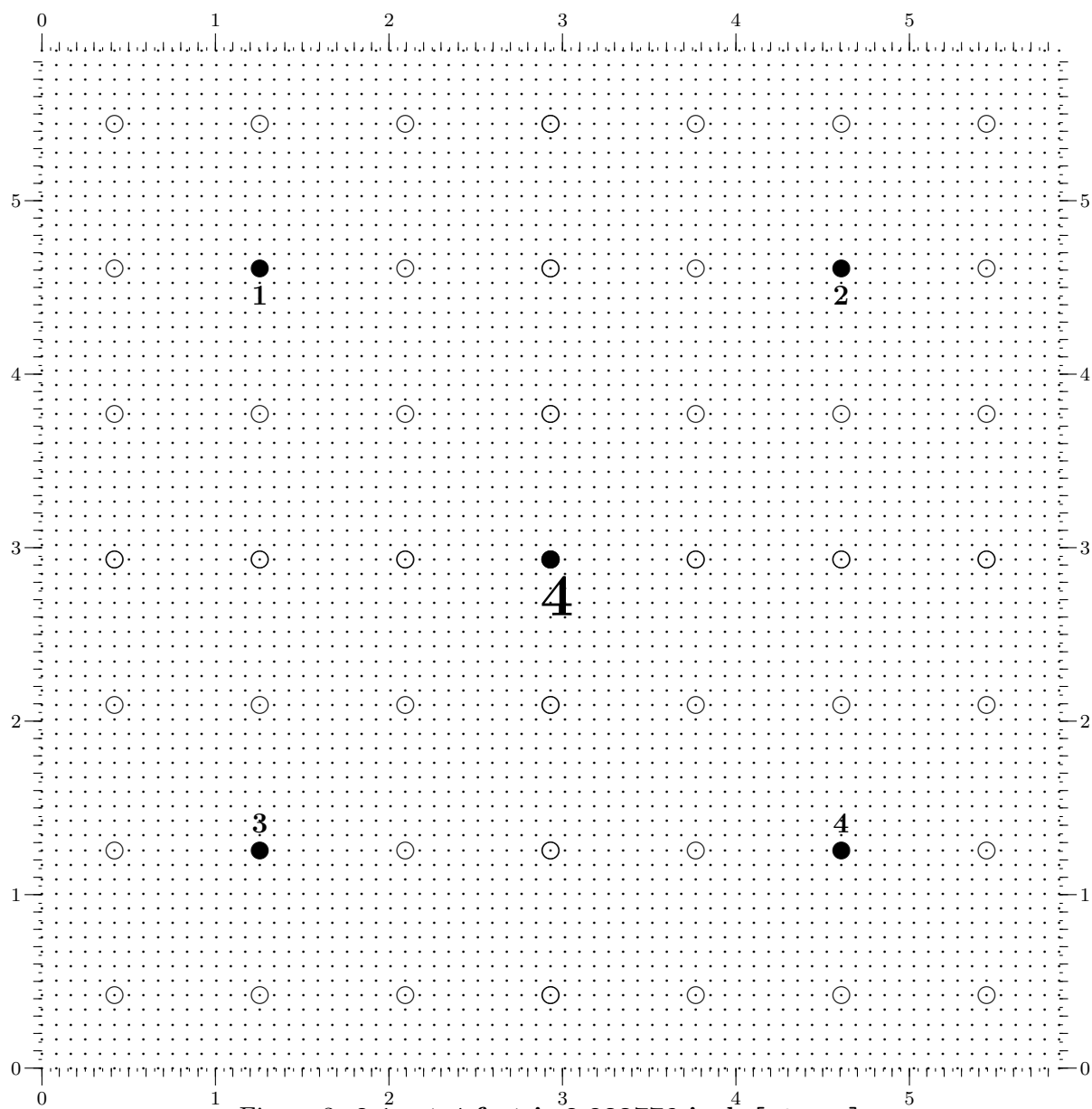
Table 3: Full, and rounded, Table of 0.1° widths for Metric Measure[metricfulltable]

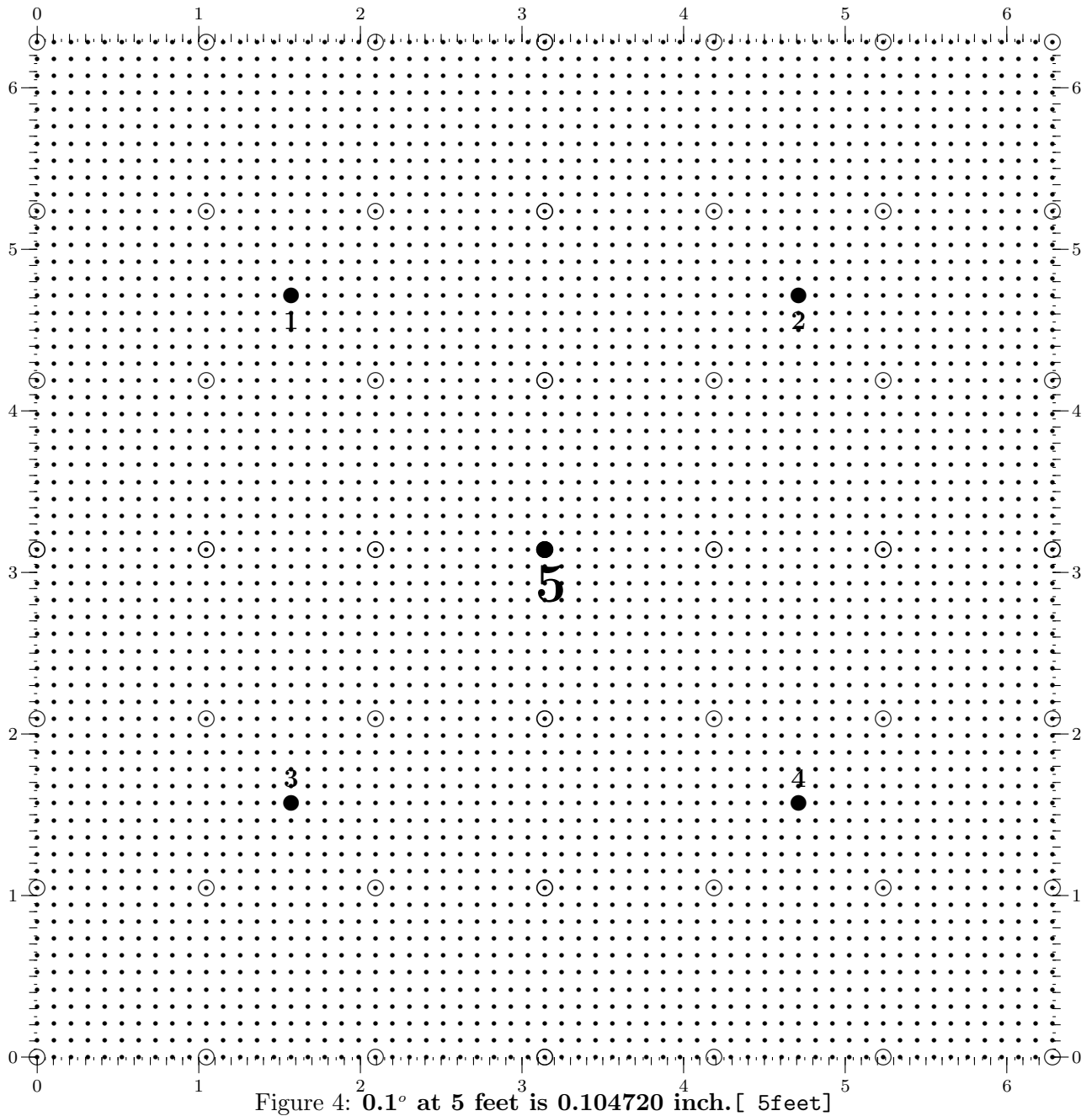
1.2 English Measure Calibration Grids

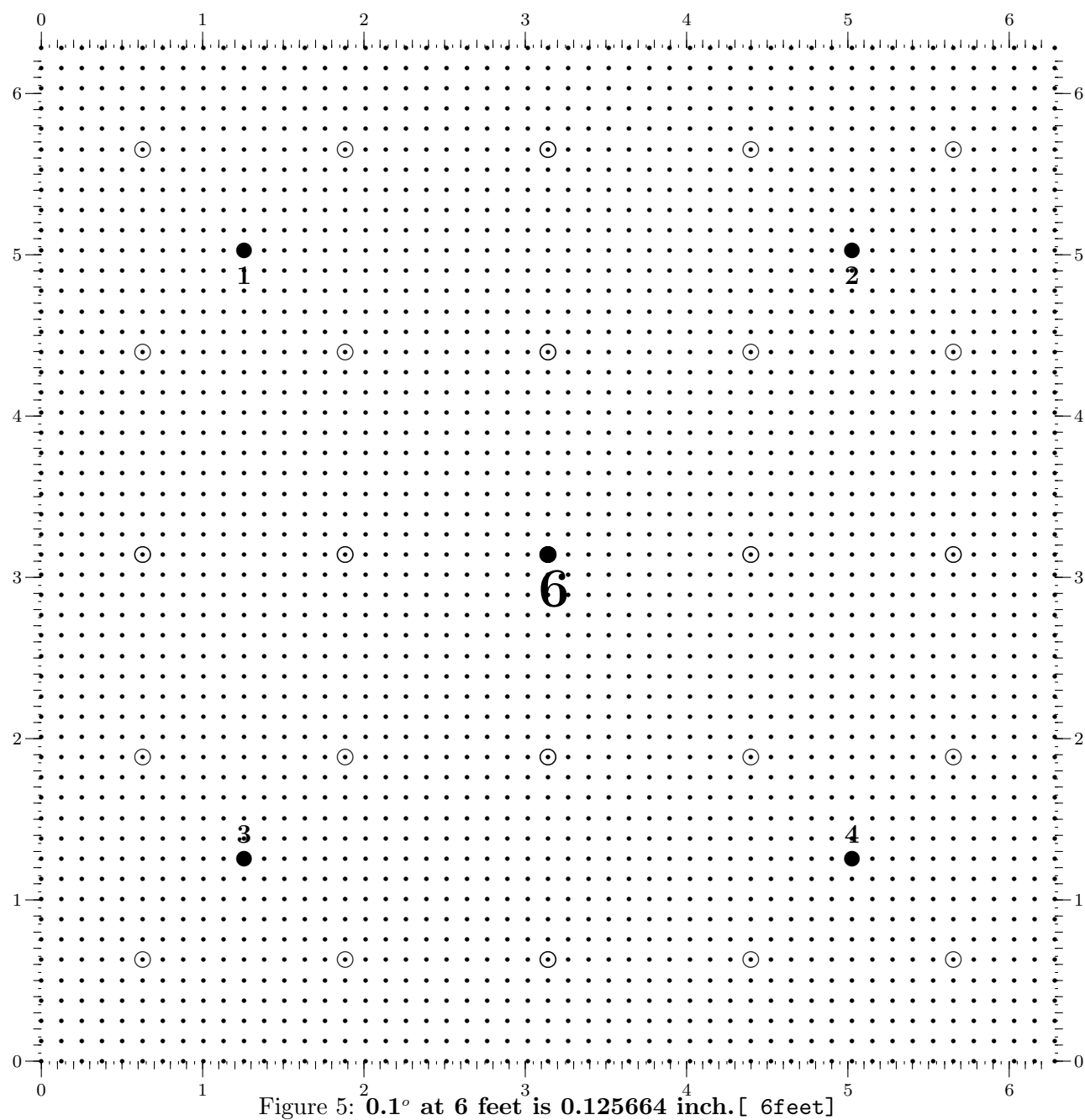
Distance	Page
2	Figure 1, page 11
3	Figure 2, page 12
4	Figure 3, page 13
5	Figure 4, page 14
6	Figure 5, page 15
7	Figure 6, page 16
8	Figure 7, page 17
9	Figure 8, page 18
10	Figure 9, page 19
11	Figure 10, page 20
12	Figure 11, page 21
14	Figure 12, page 22
16	Figure 13, page 23
18	Figure 14, page 24
20	Figure 15, page 25
22	Figure 16, page 26
24	Figure 17, page 27
26	Figure 18, page 28
28	Figure 19, page 29
30	Figure 20, page 30
32	Figure 21, page 31
34	Figure 22, page 32
36	Figure 23, page 33
38	Figure 24, page 34
40	Figure 25, page 35
42	Figure 26, page 36
44	Figure 27, page 37
46	Figure 28, page 38
48	Figure 29, page 39
50	Figure 30, page 40
52	Figure 31, page 41
54	Figure 32, page 42
56	Figure 33, page 43

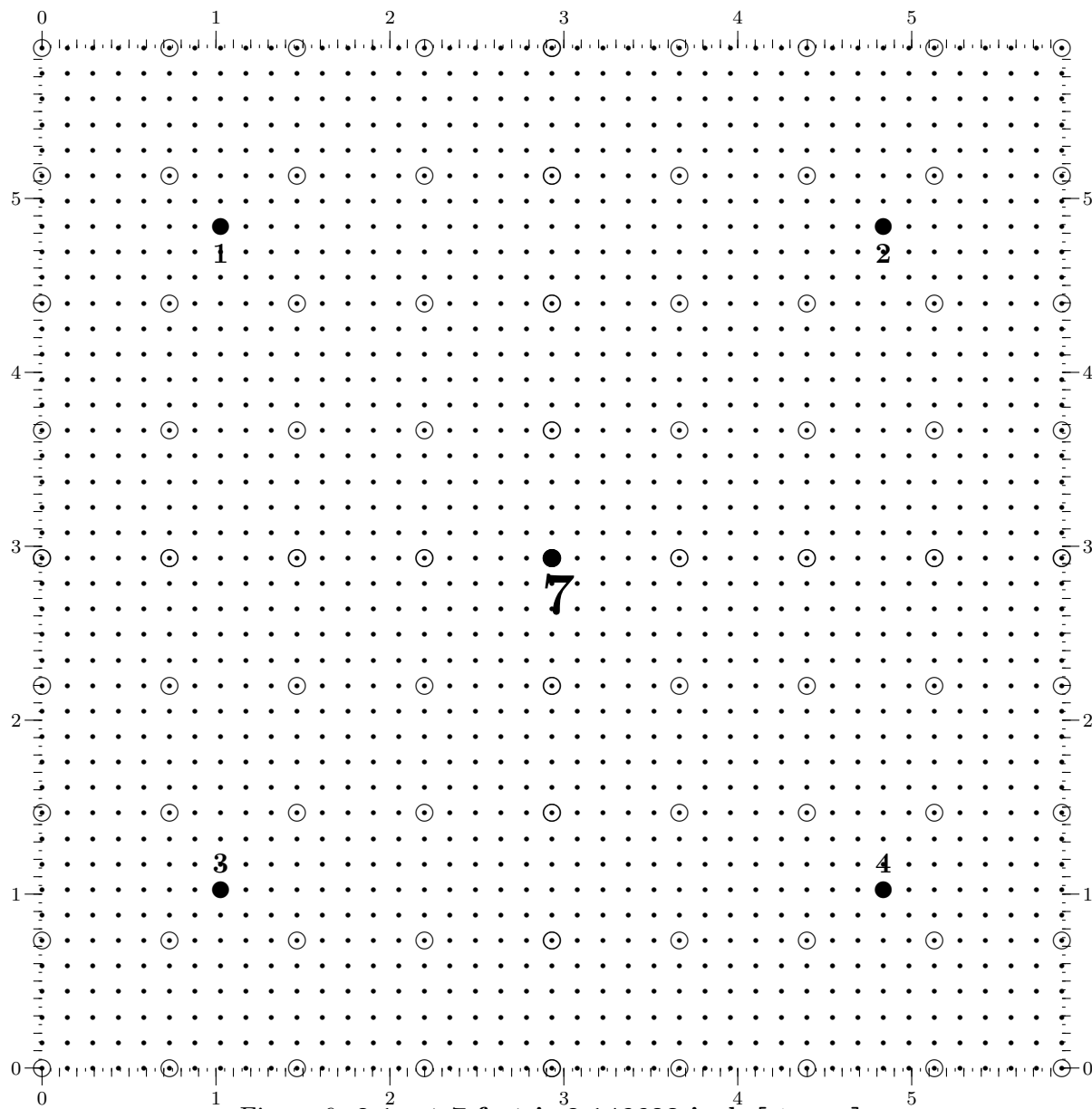


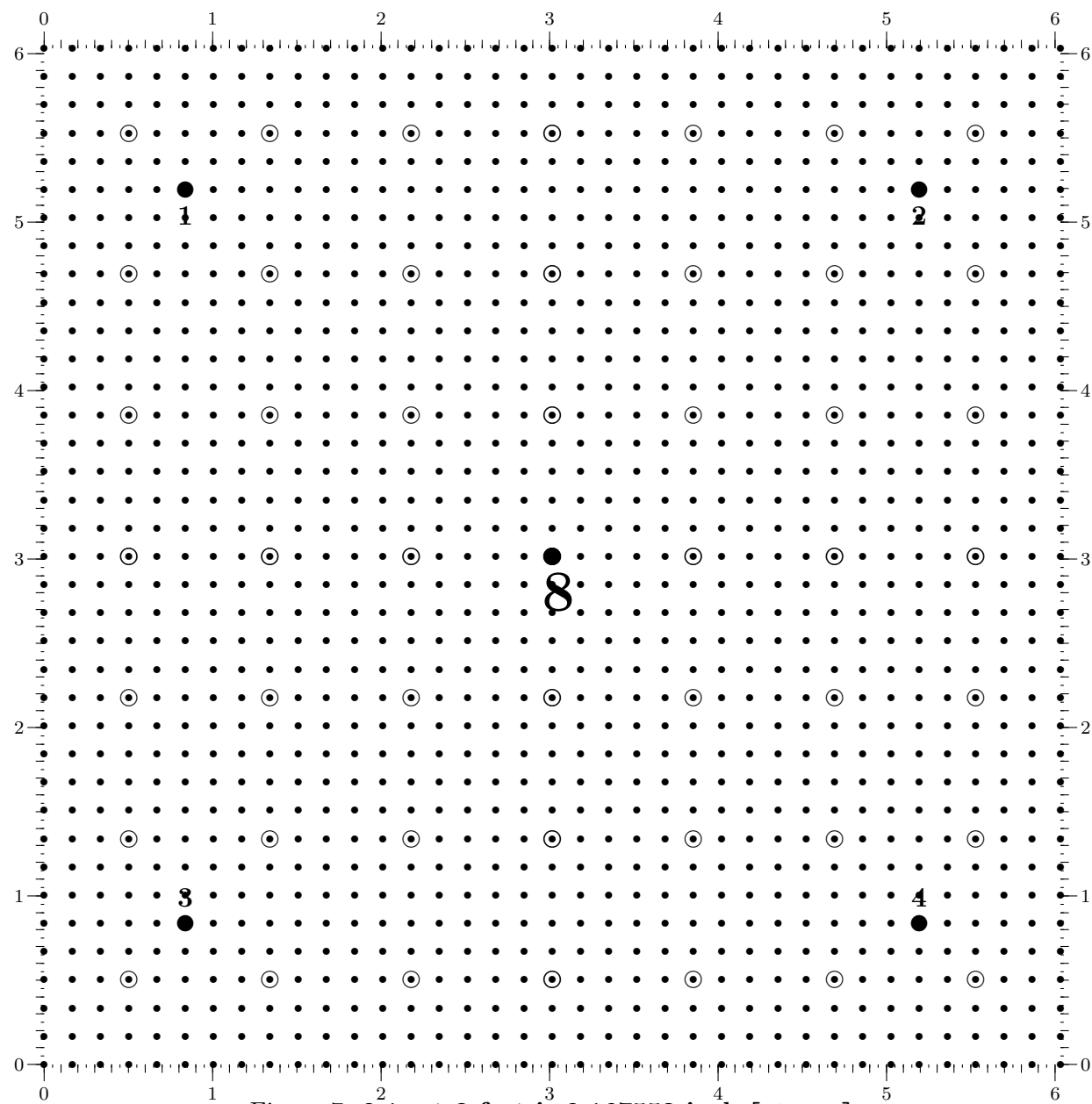












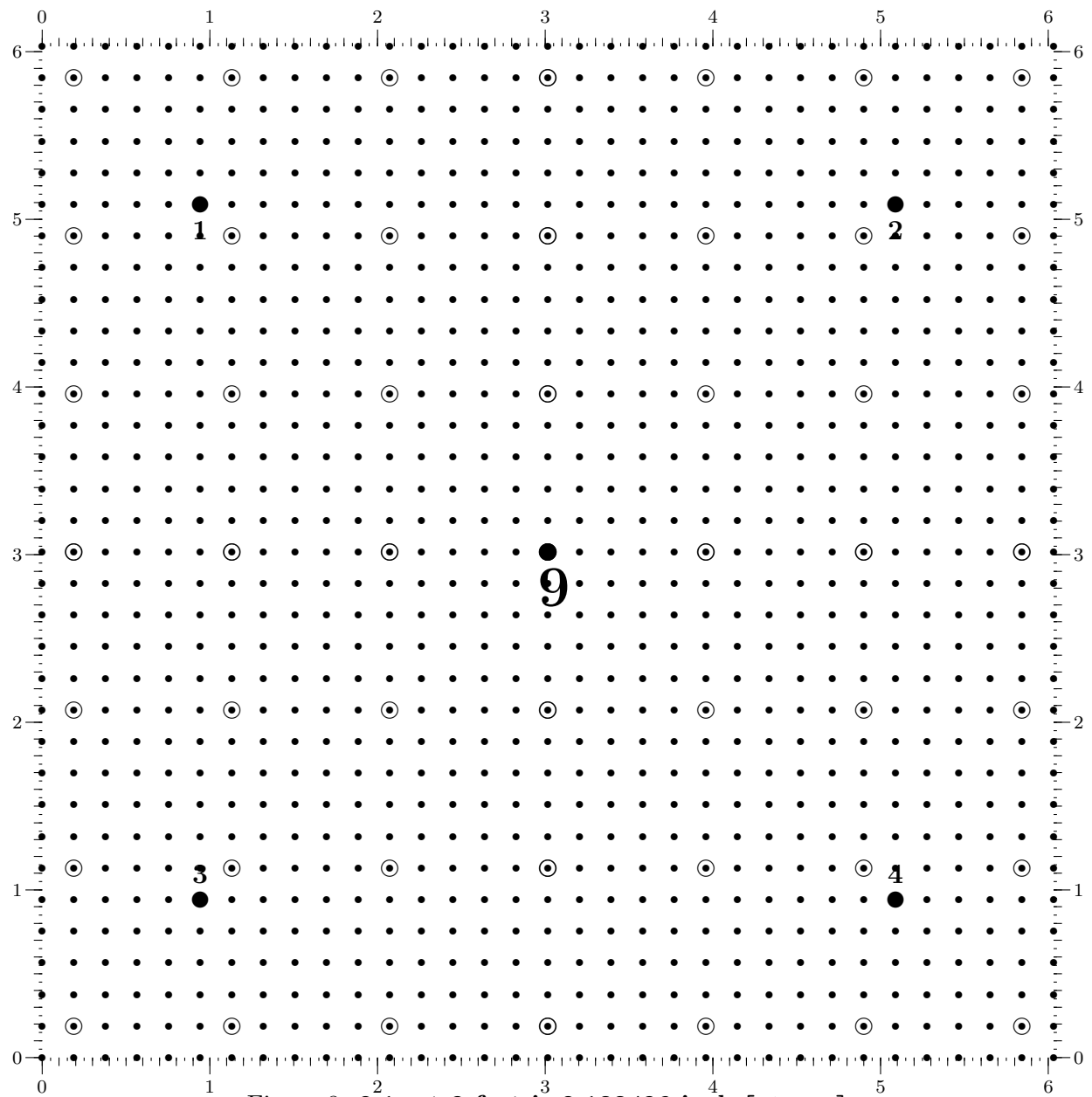
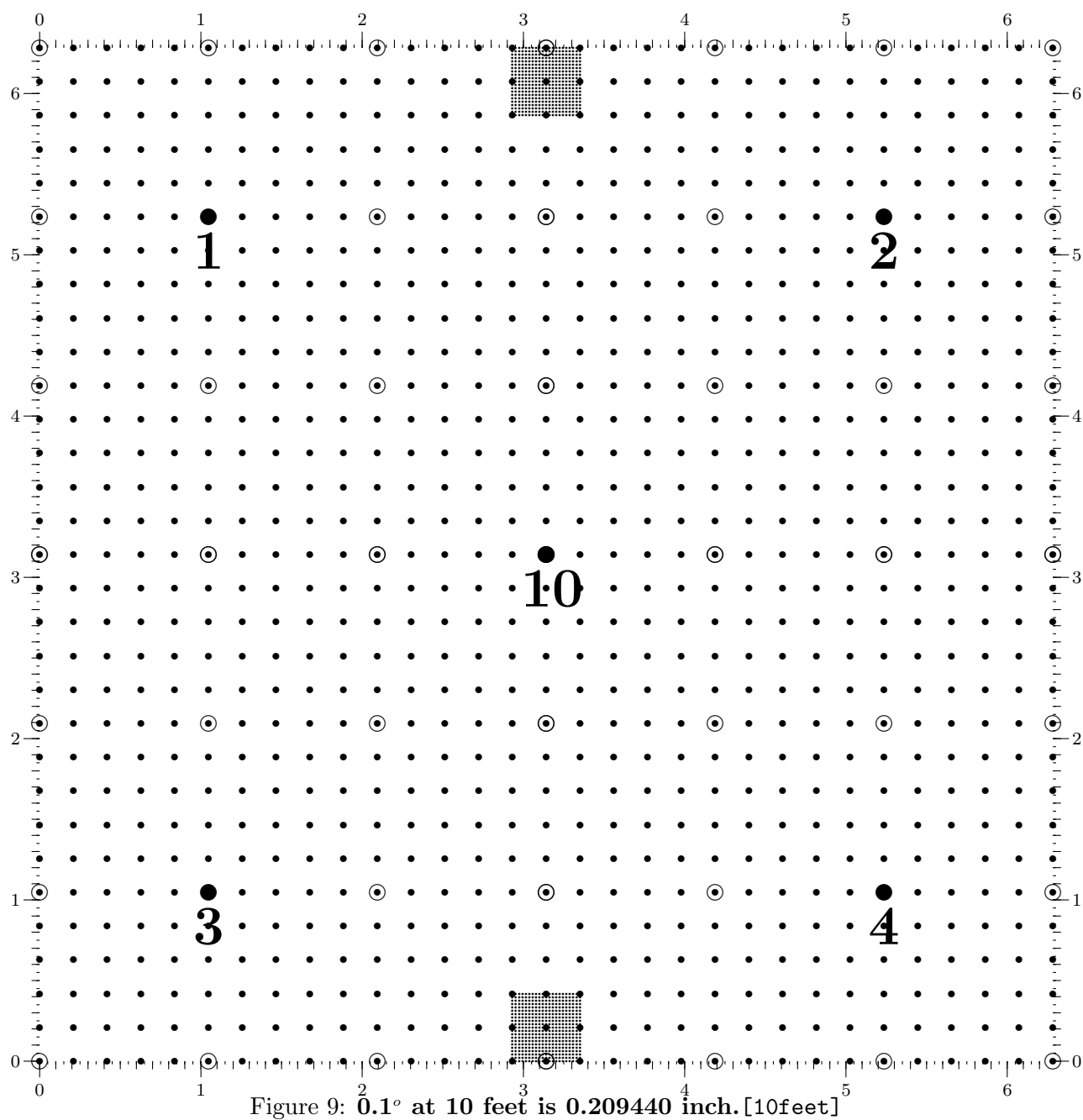
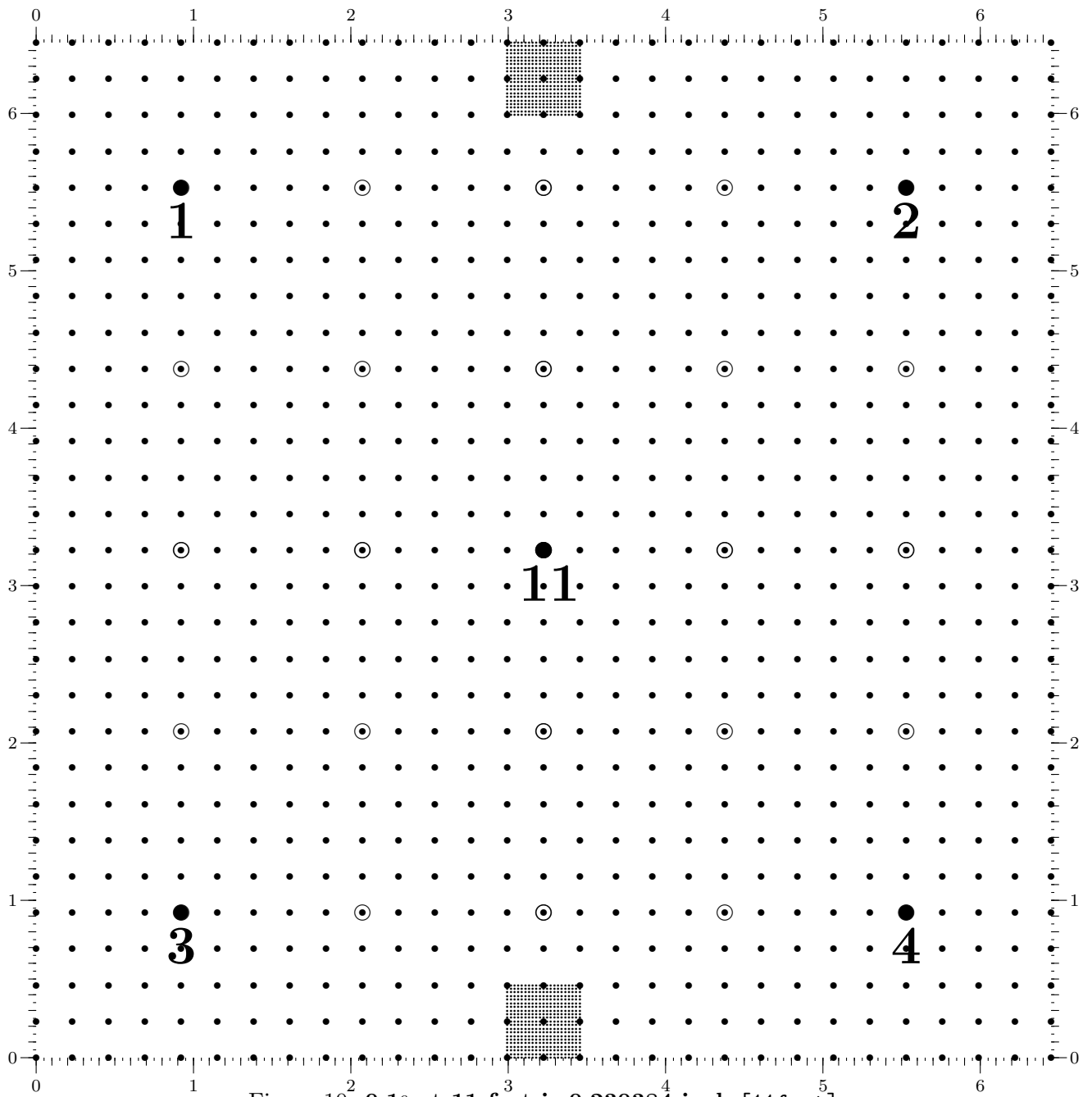
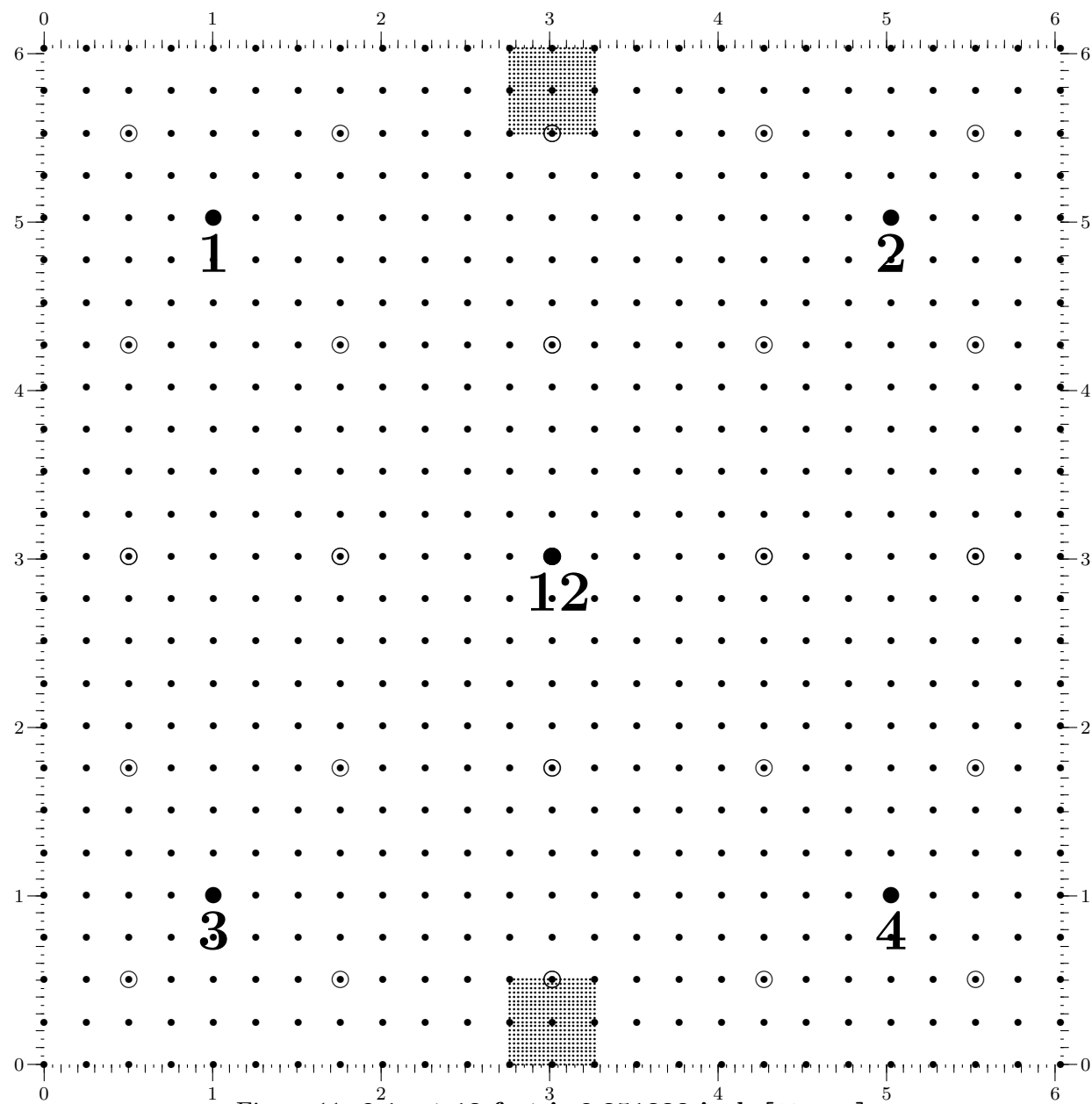
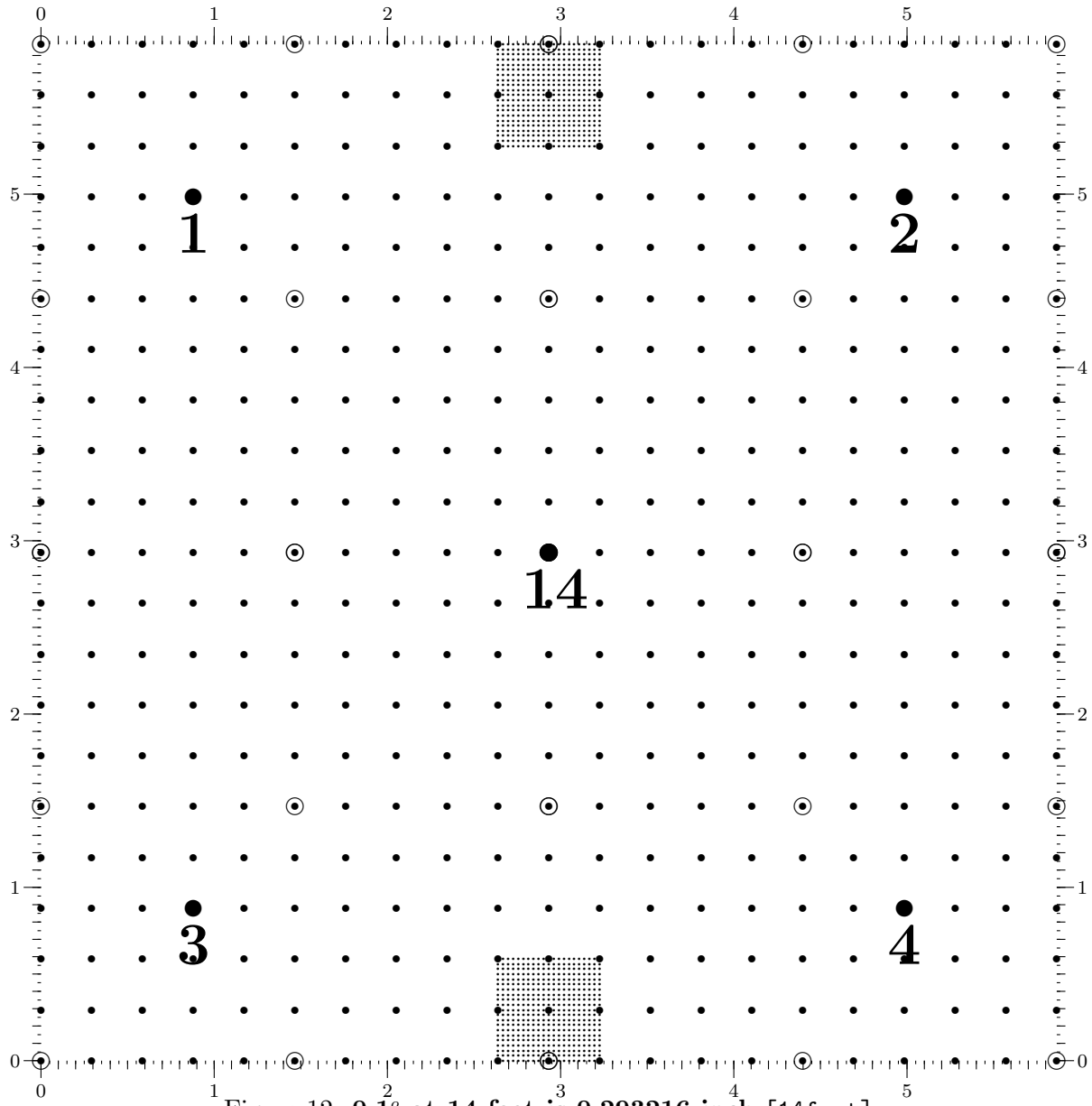


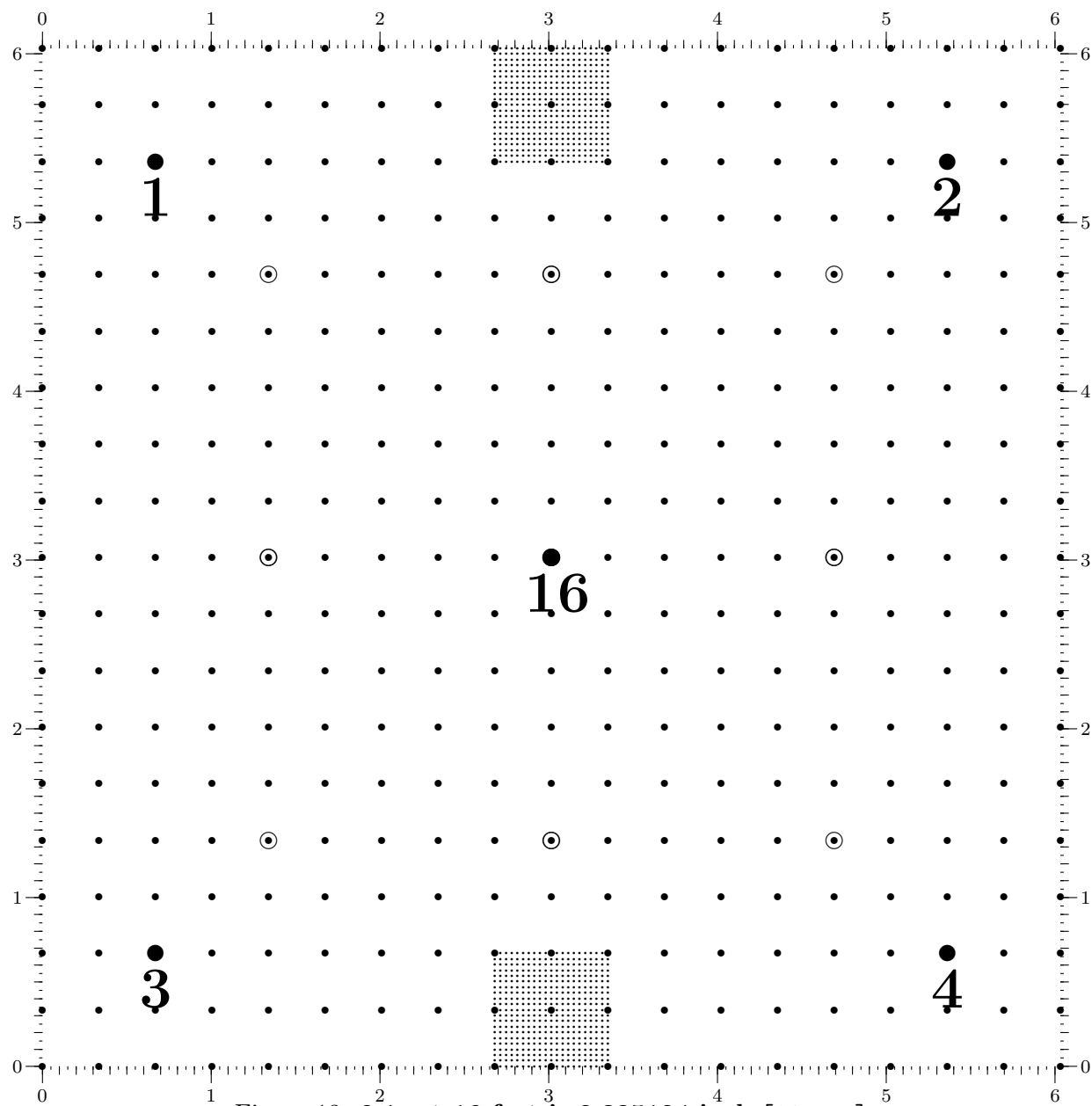
Figure 8: 0.1° at 9 feet is 0.188496 inch. [9feet]

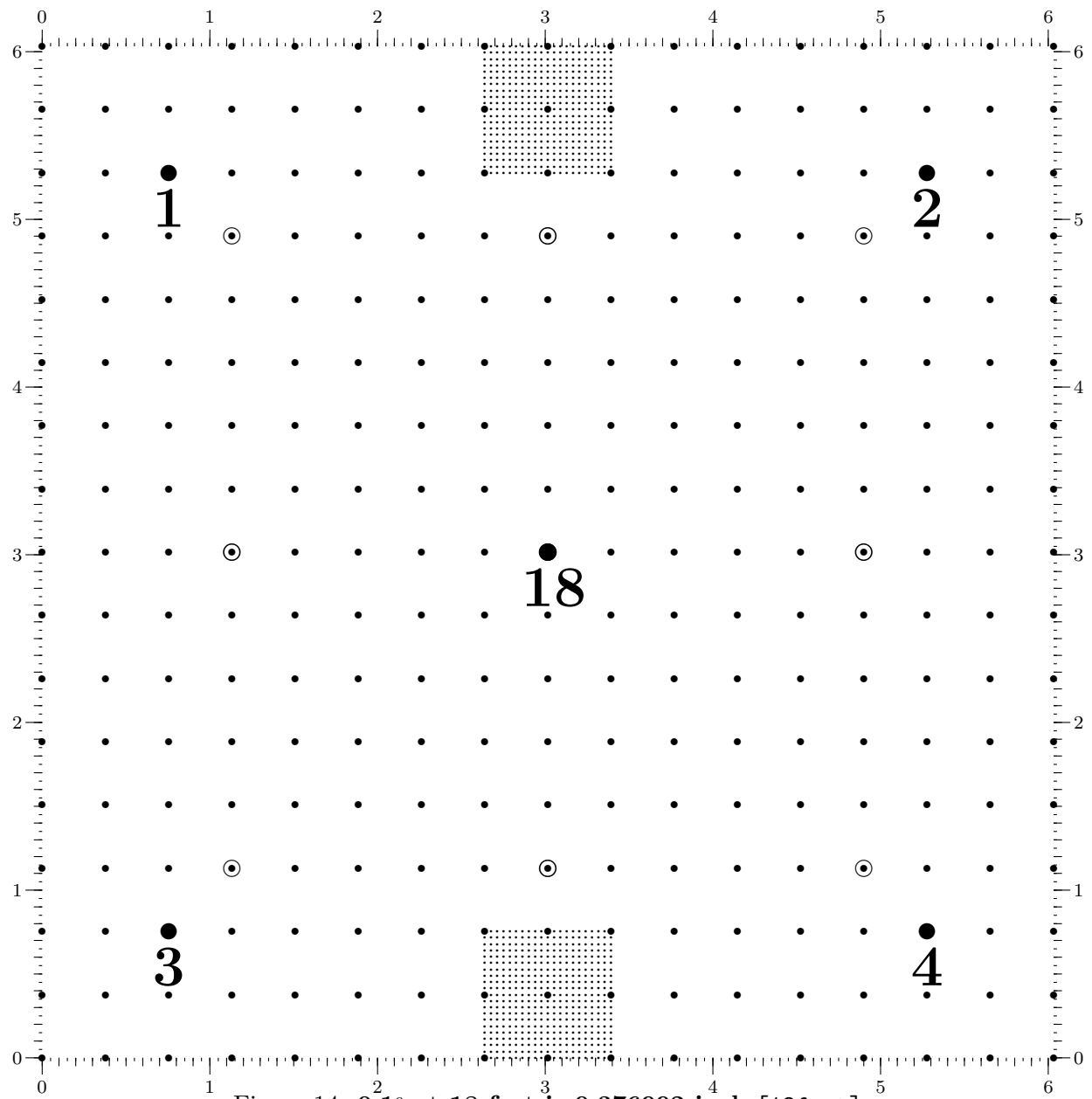


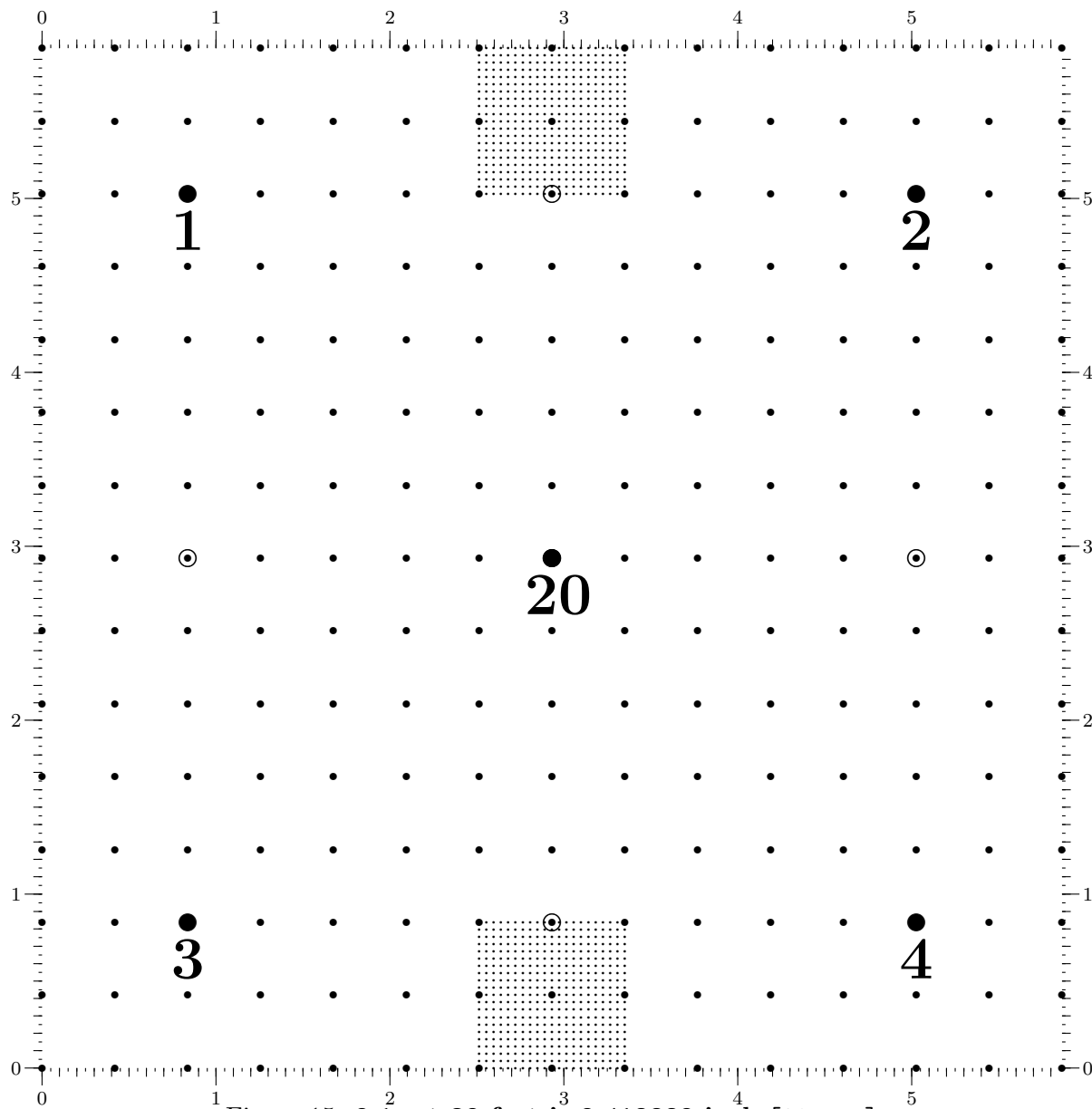


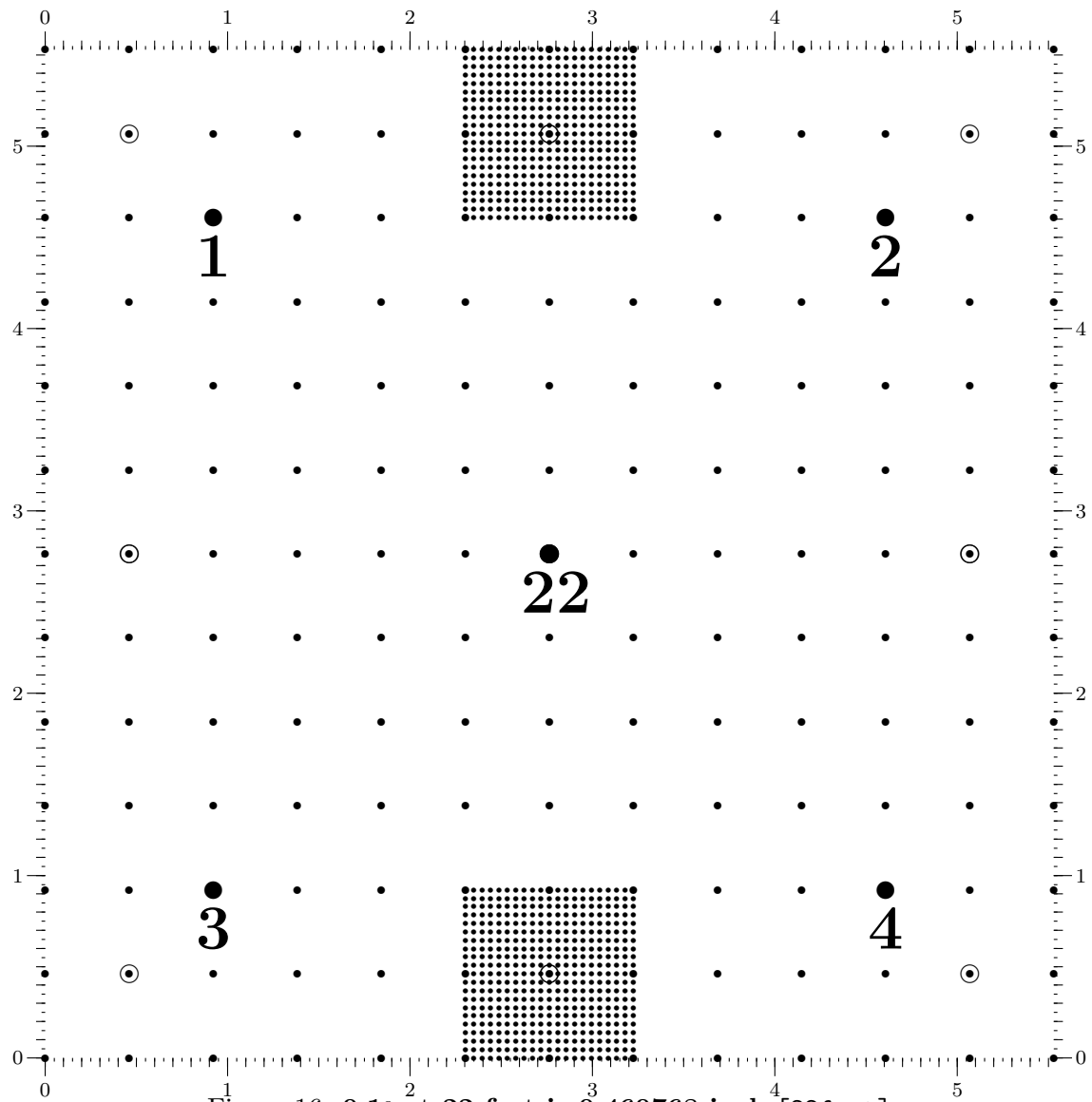












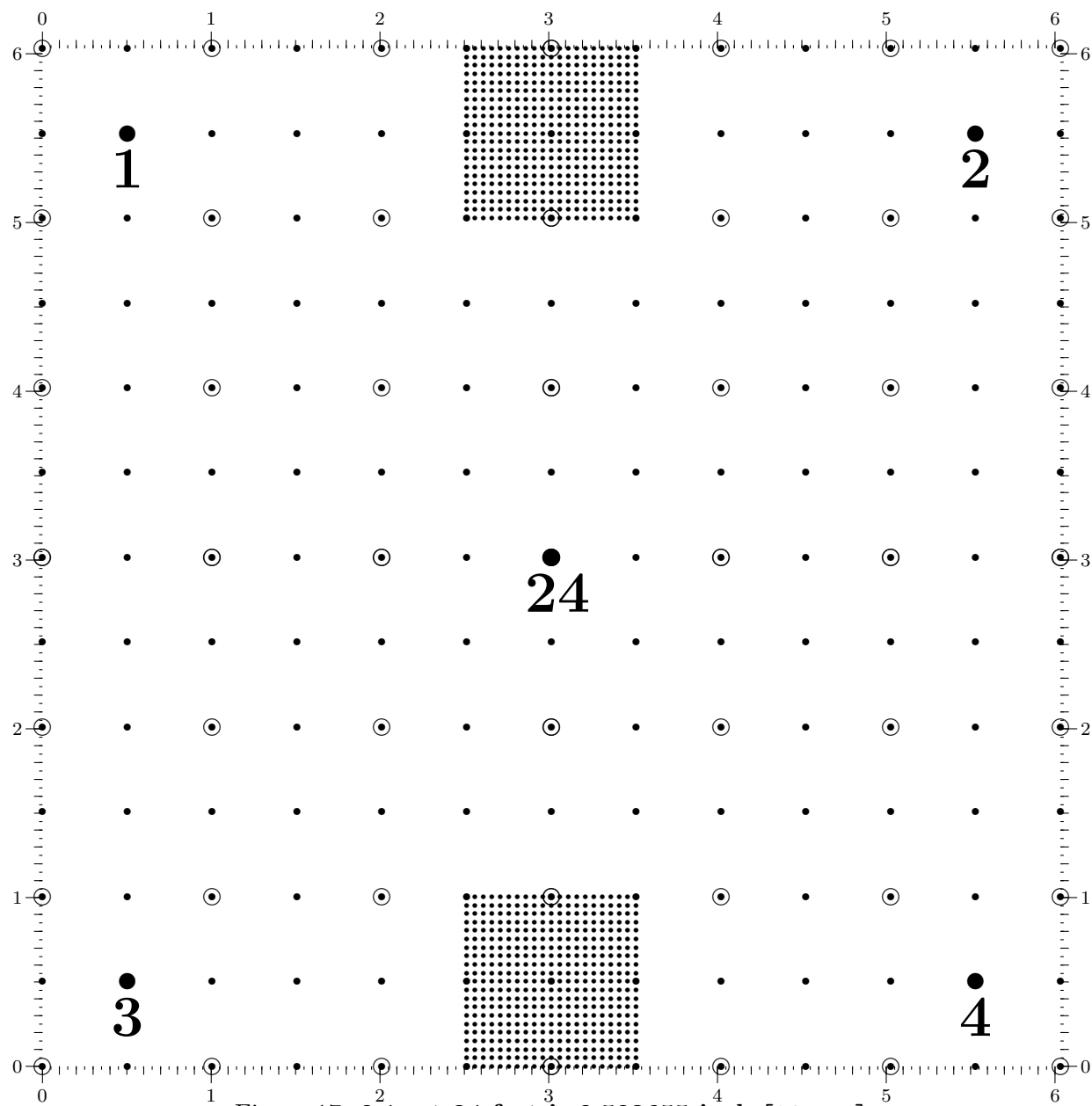
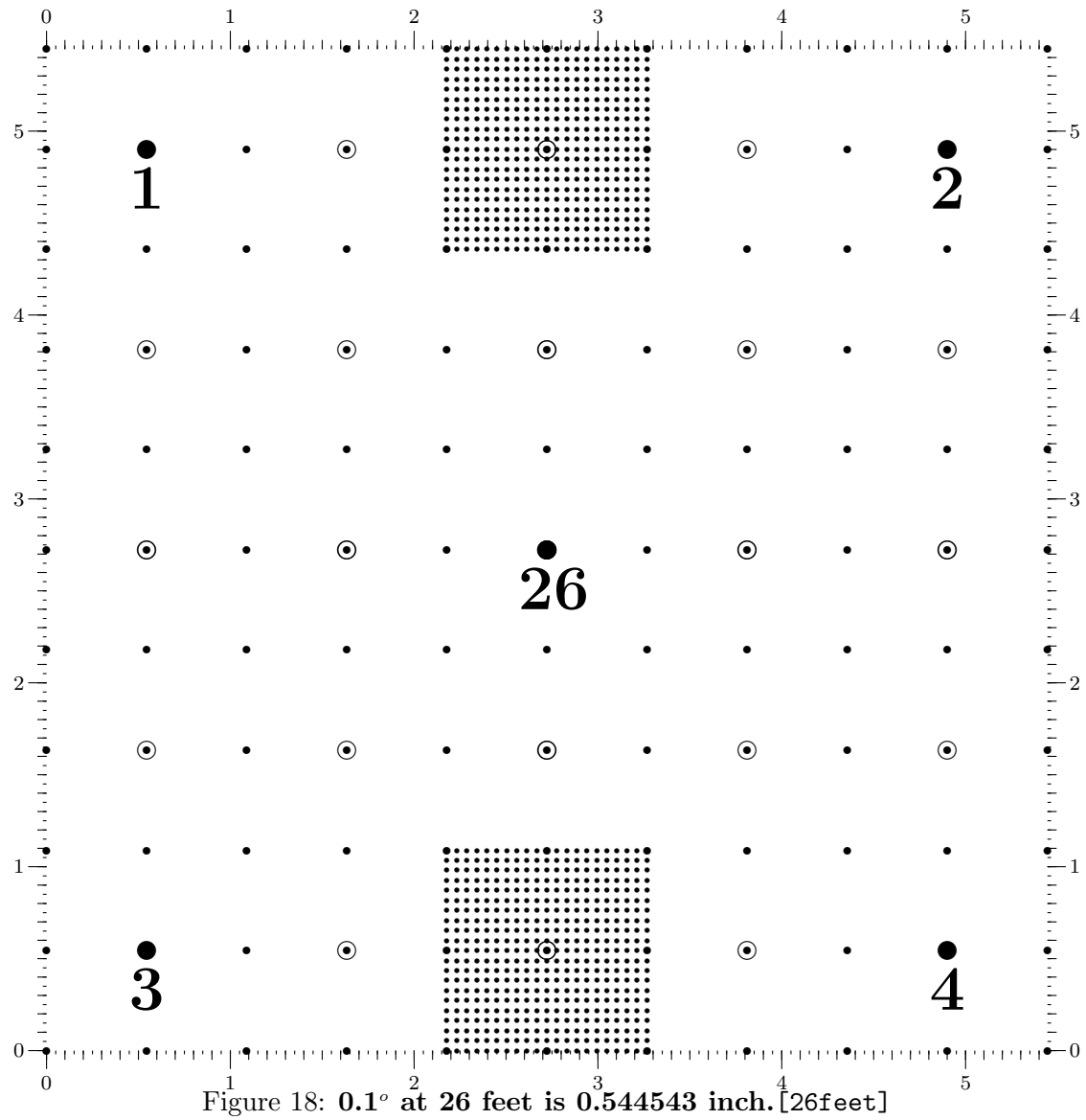
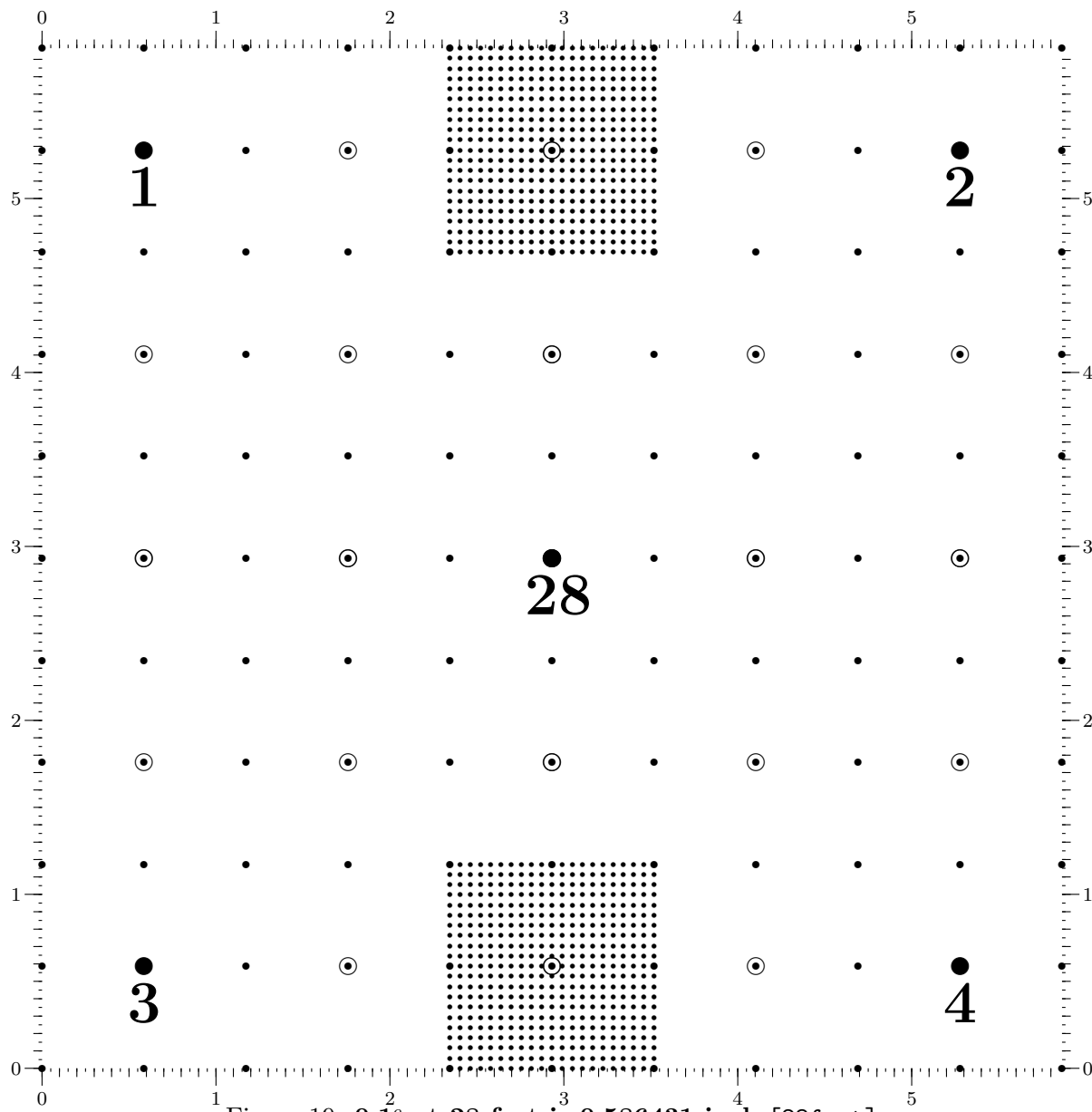
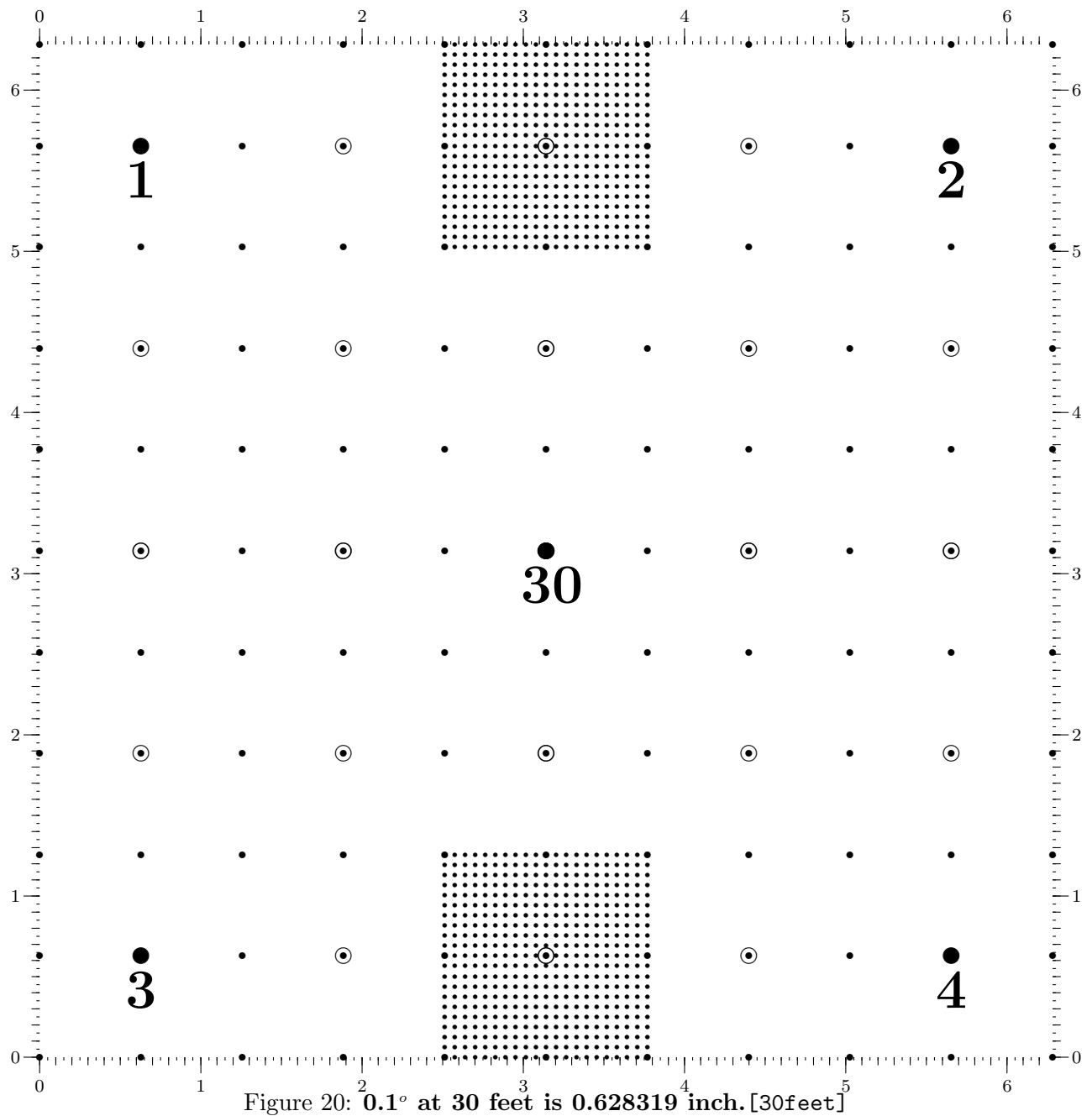
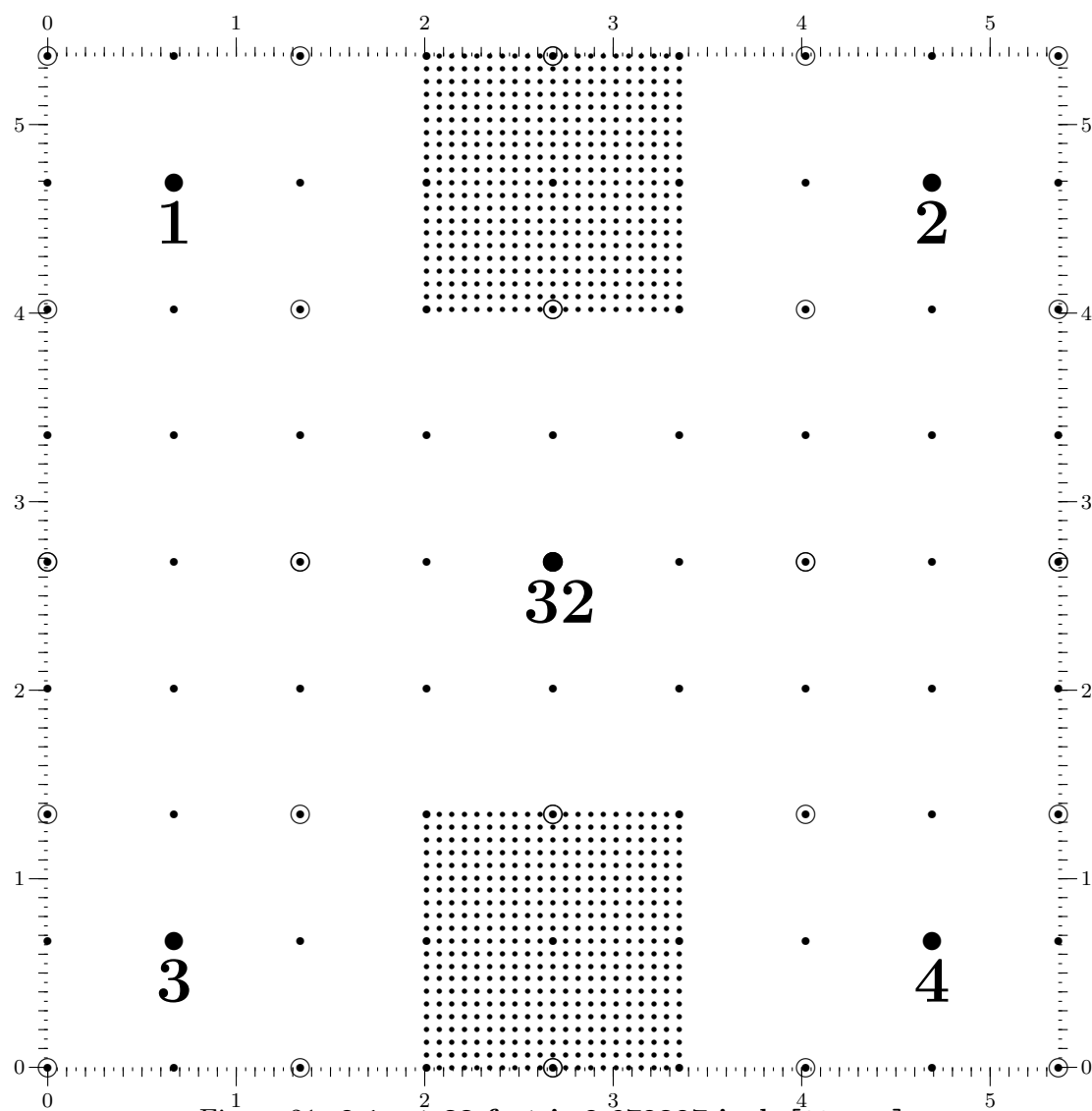


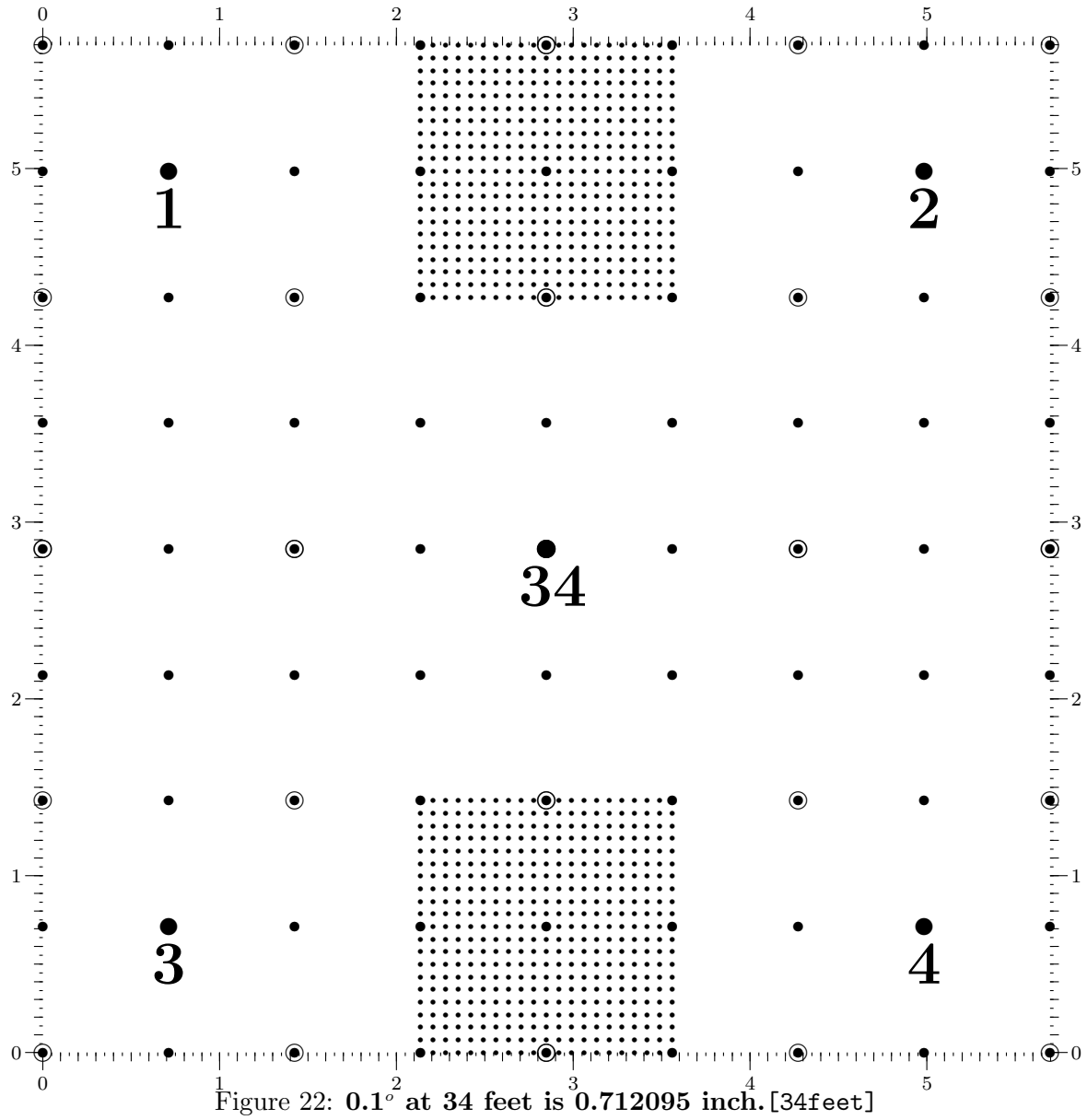
Figure 17: 0.1° at 24 feet is 0.502655 inch.[24feet]

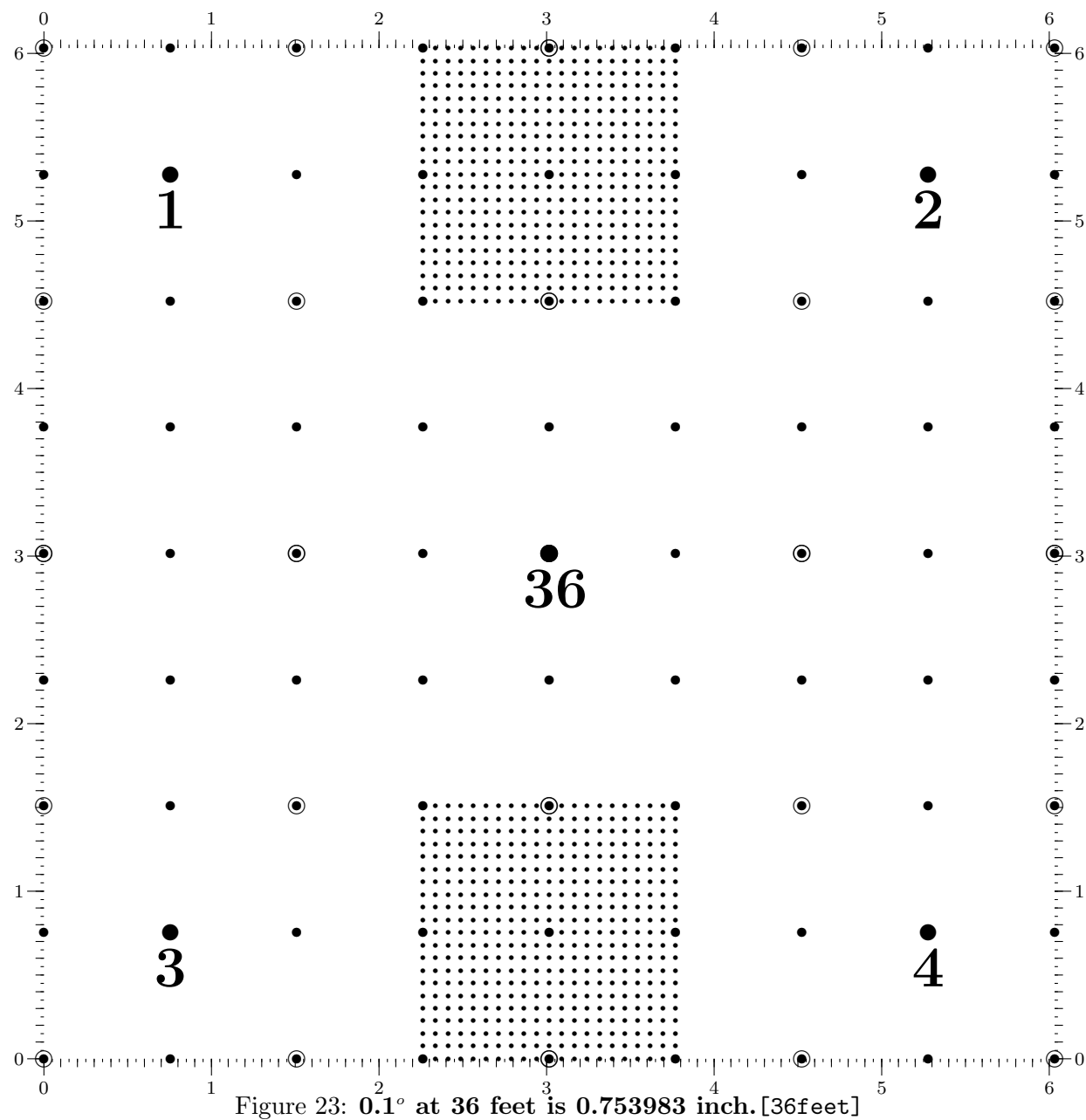


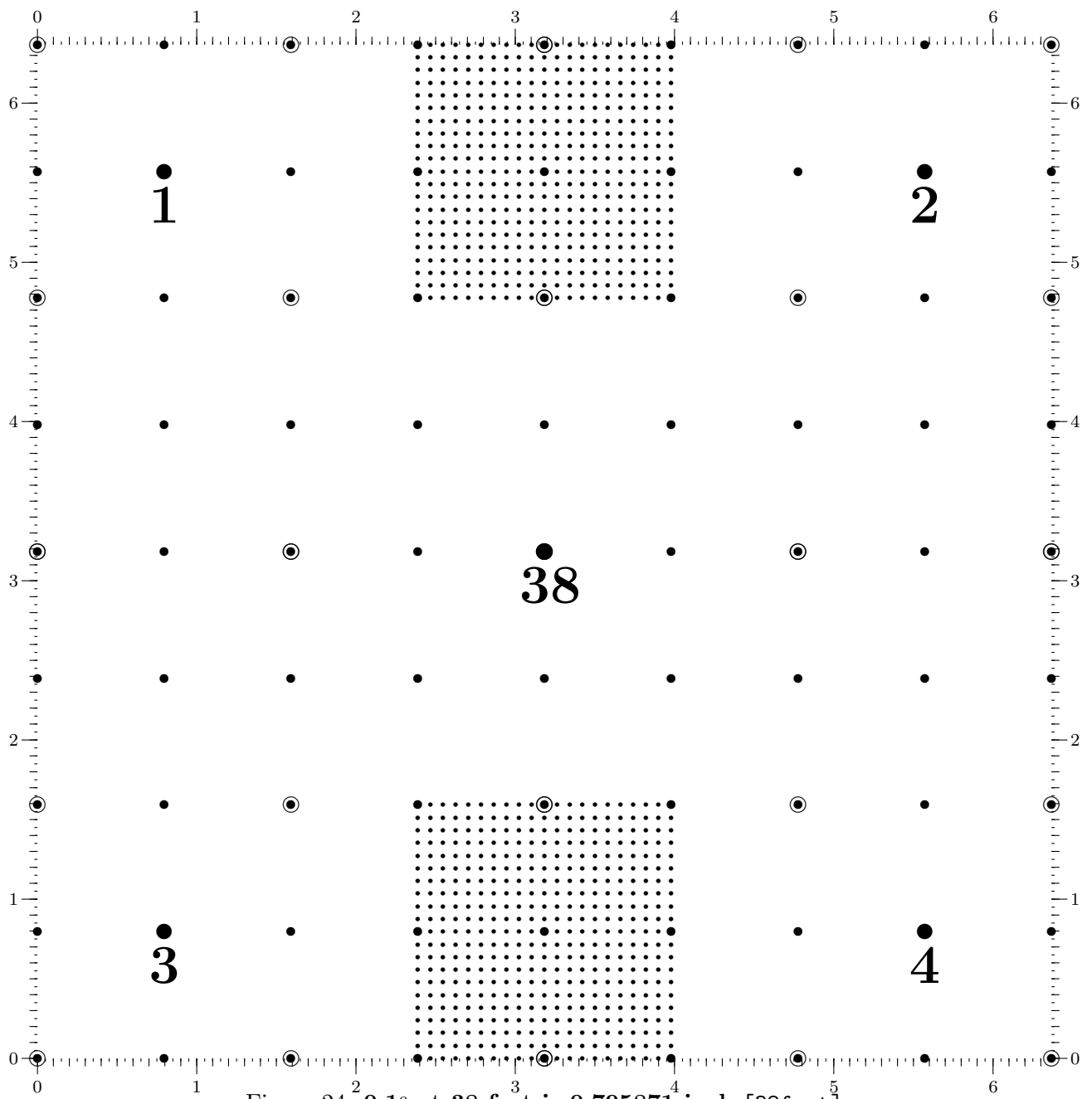












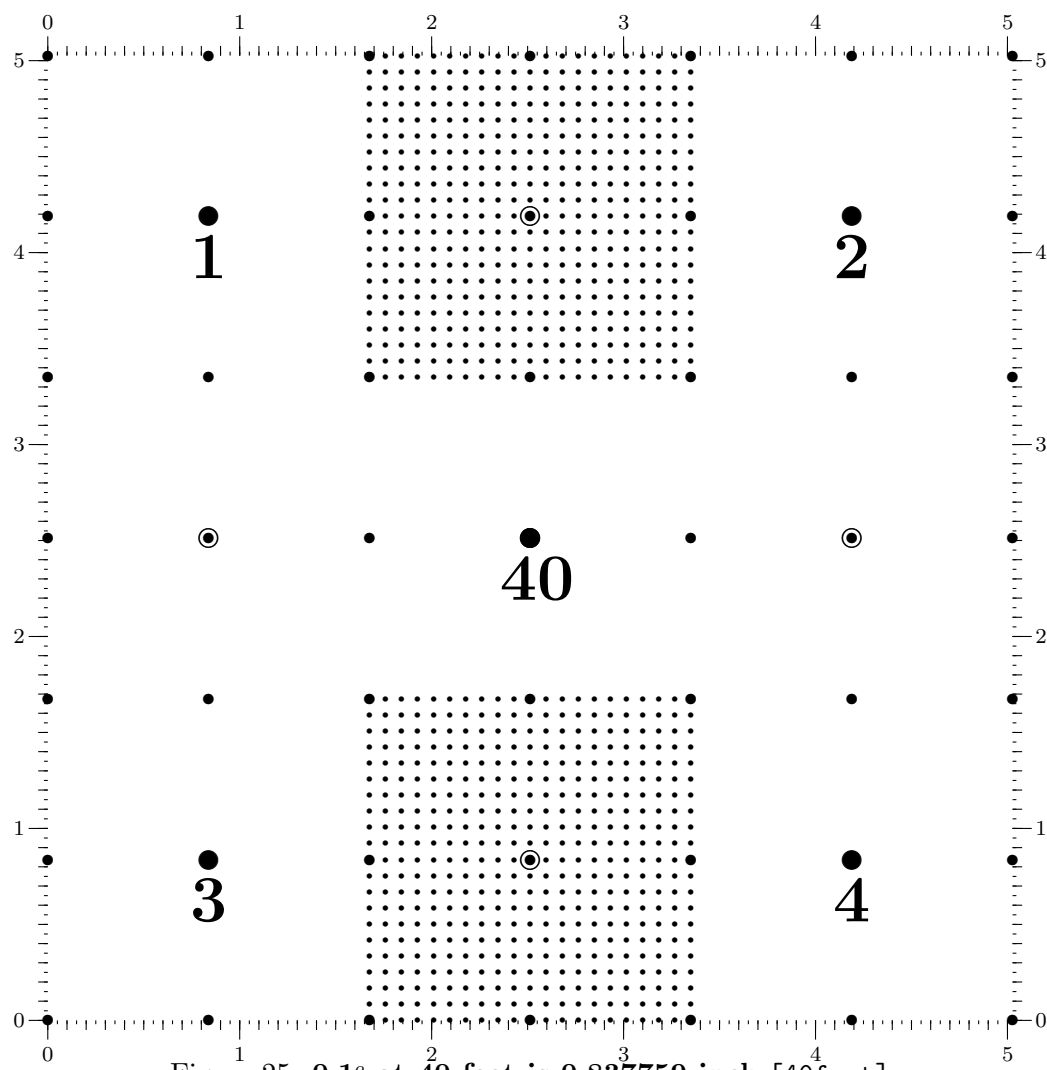


Figure 25: 0.1° at 40 feet is 0.837759 inch.[40feet]

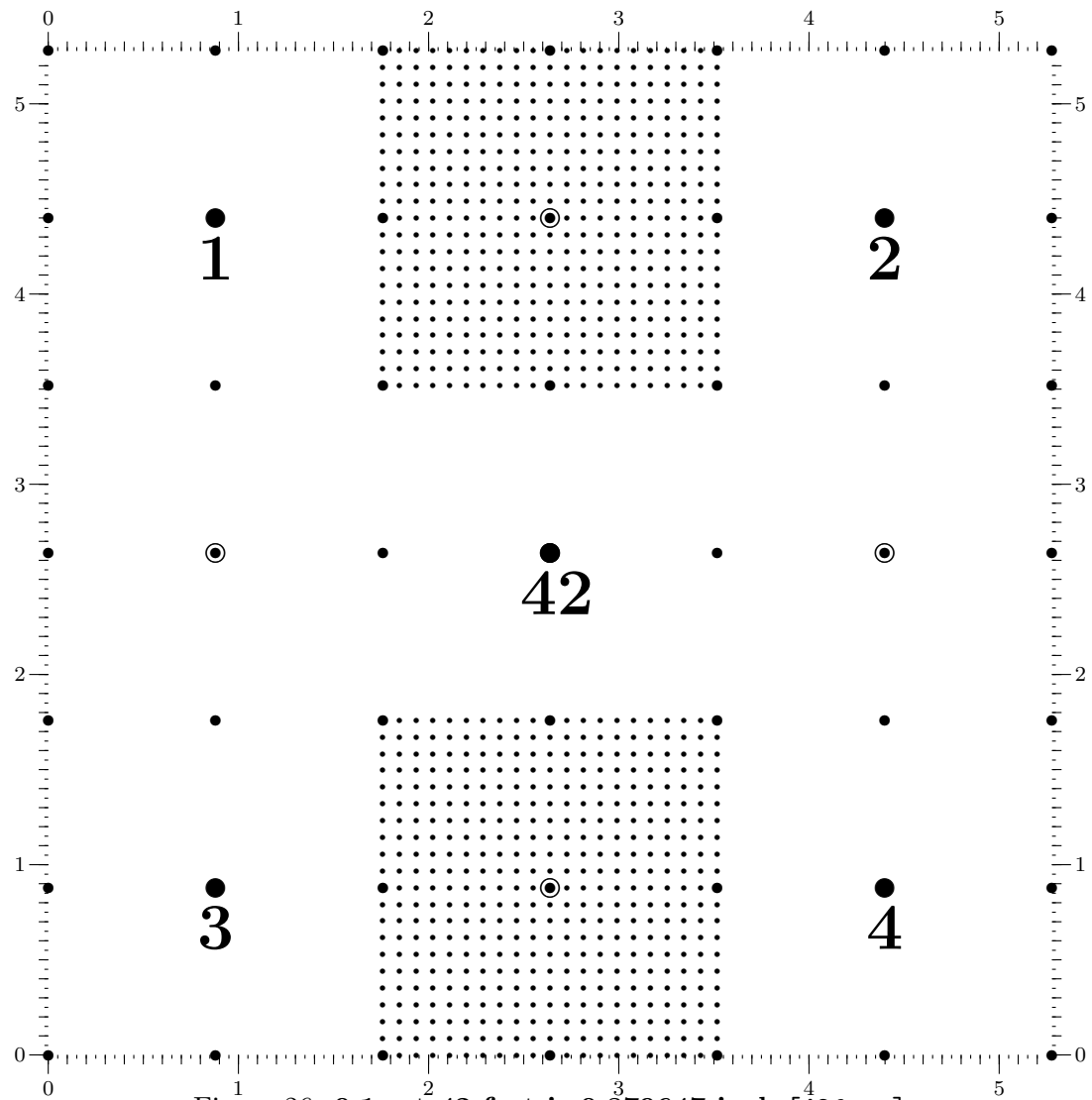
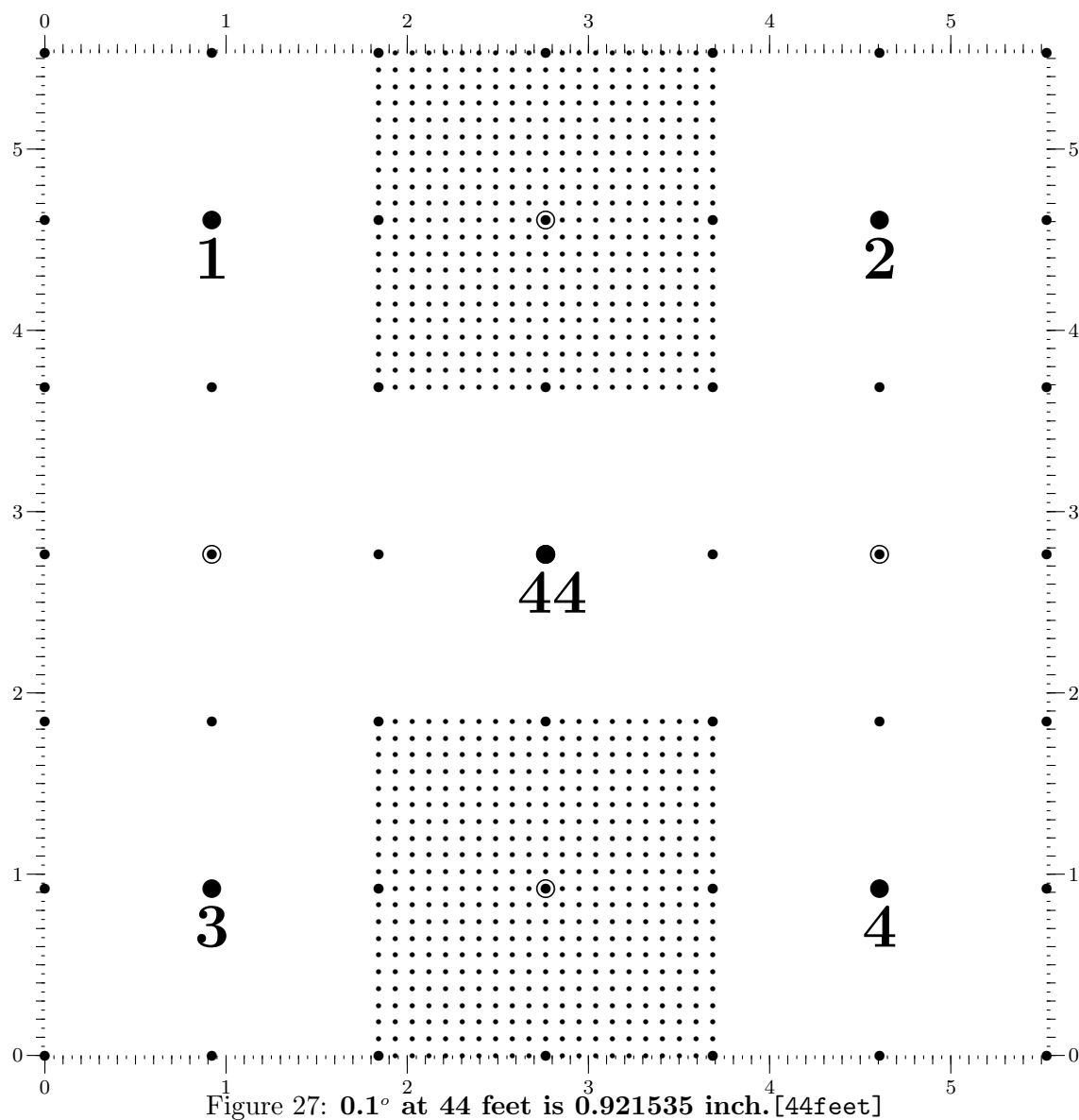
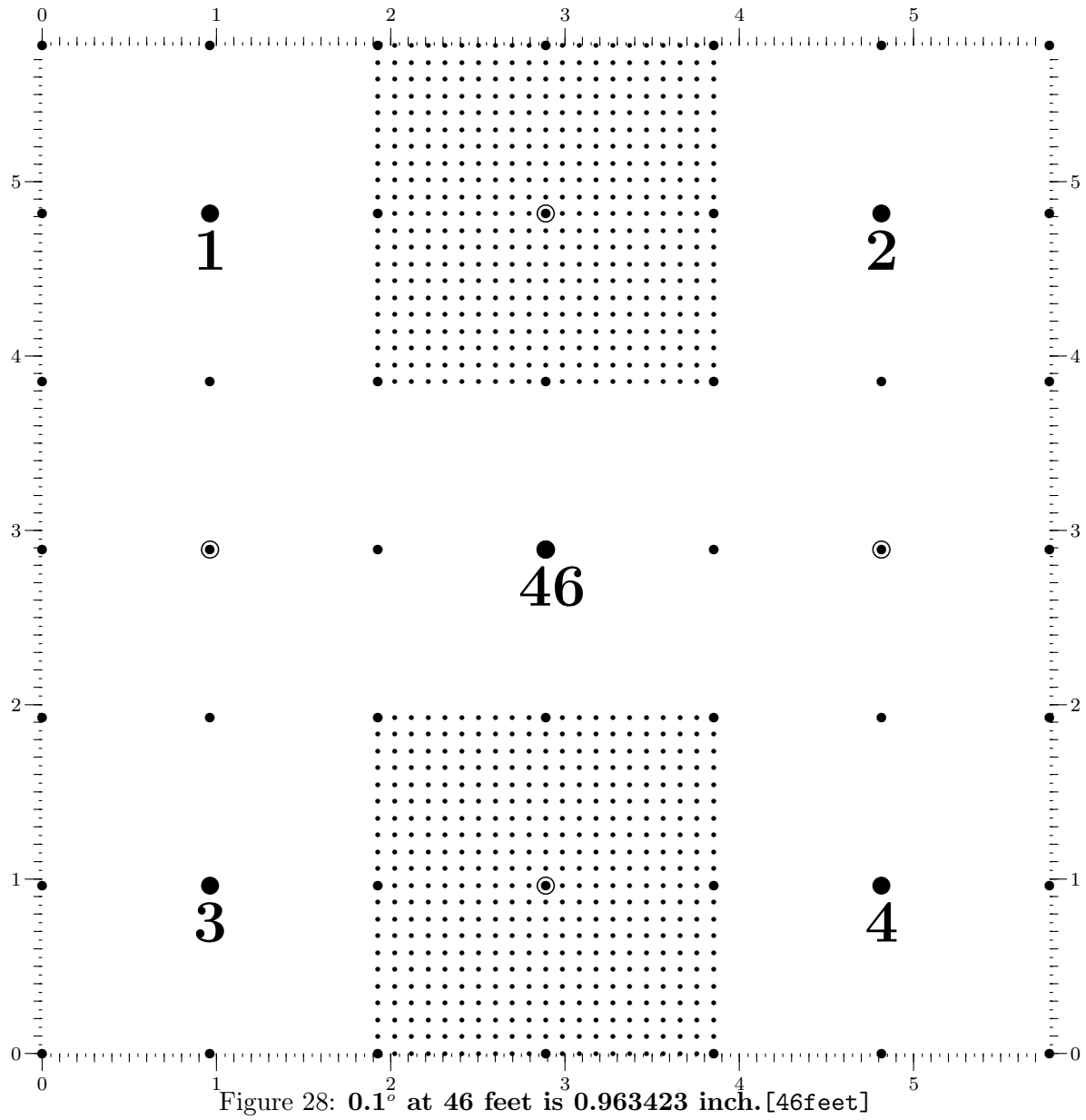


Figure 26: 0.1° at 42 feet is 0.879647 inch. [42feet]





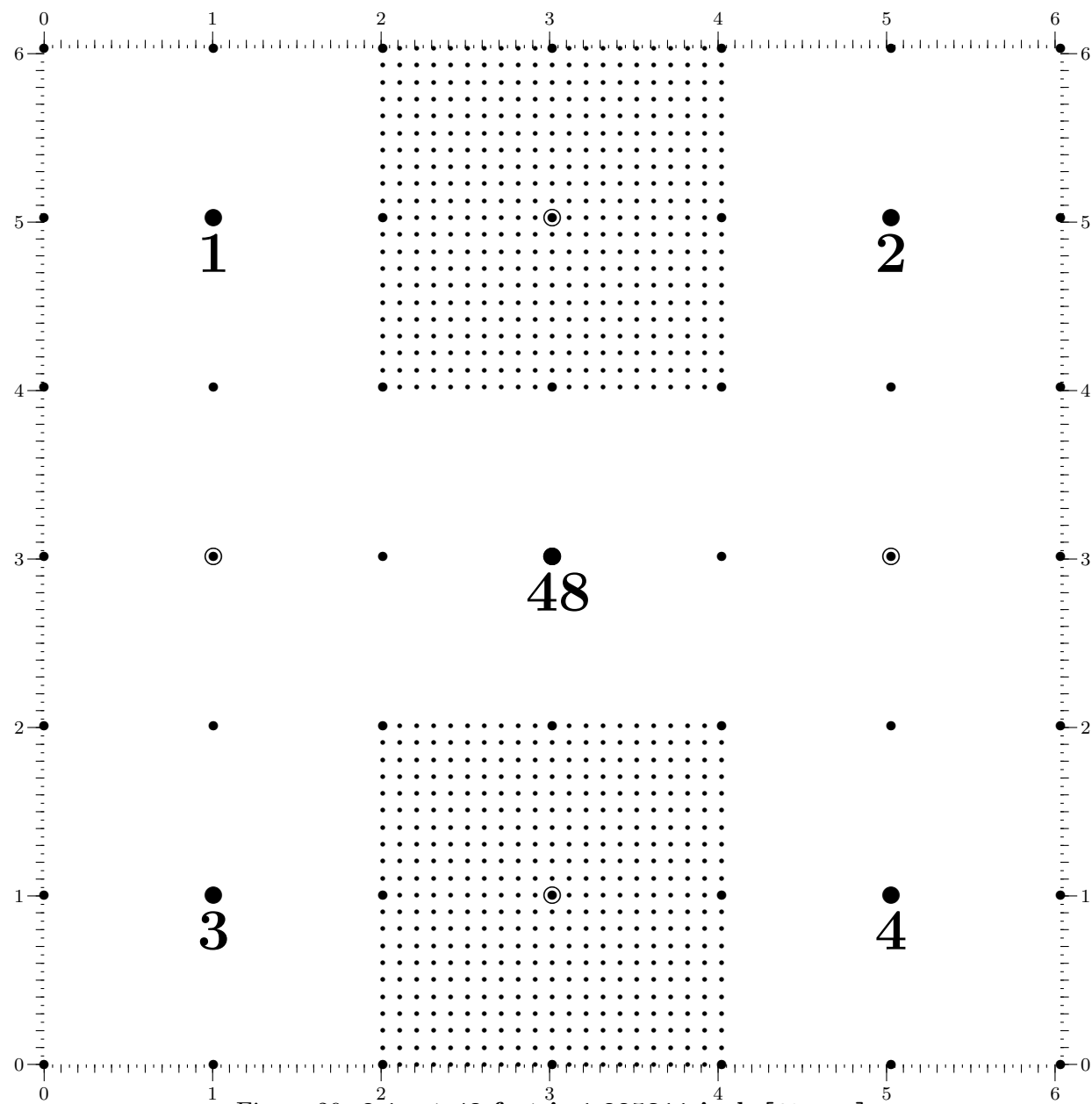
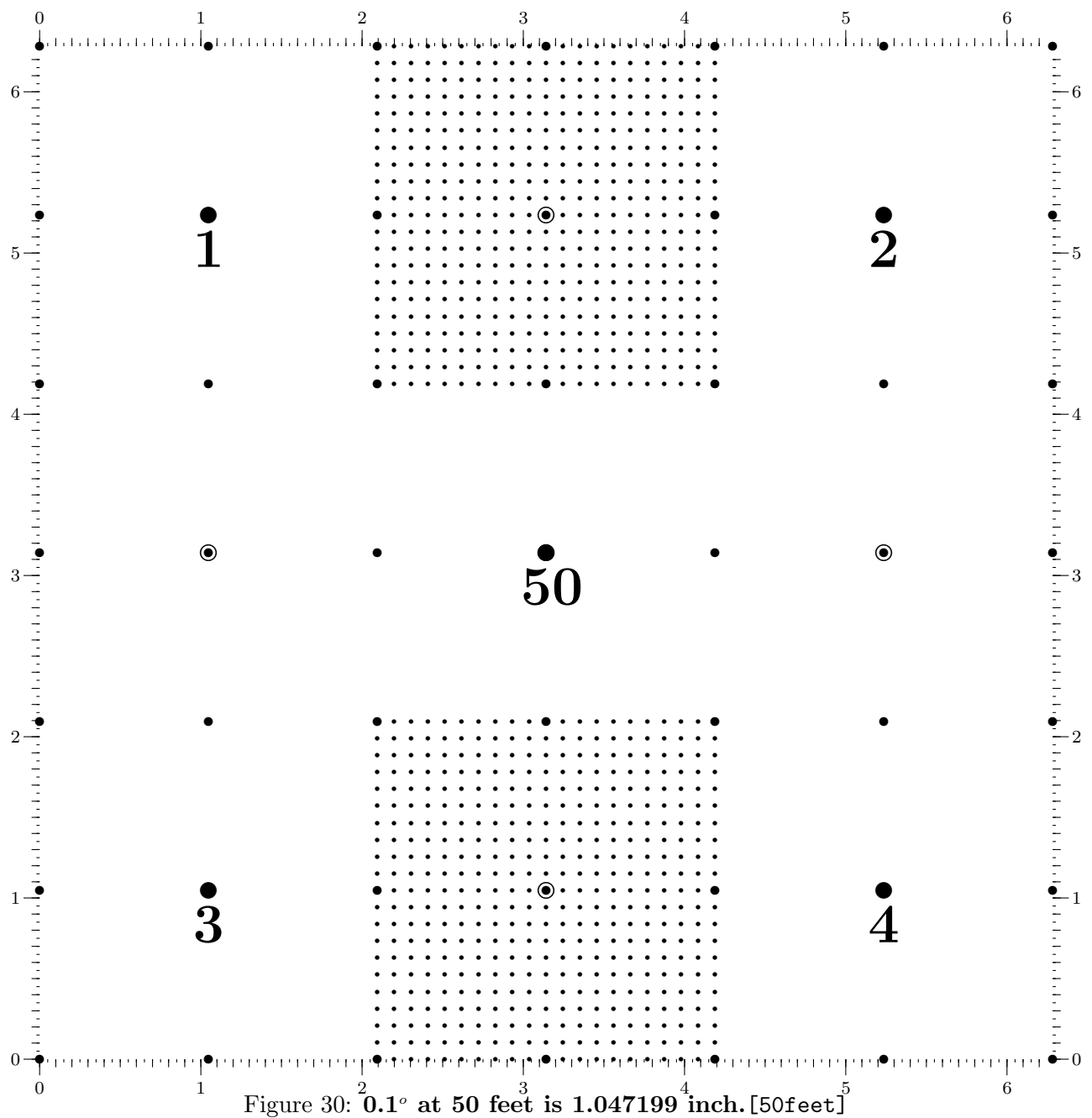
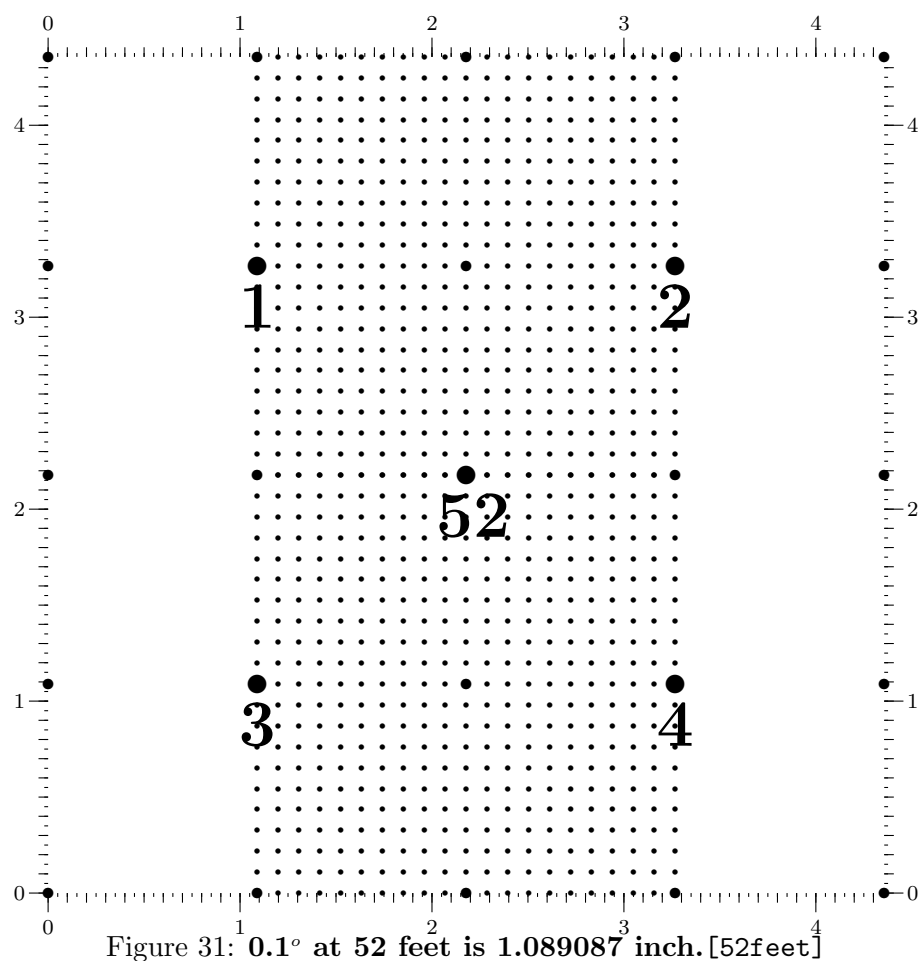


Figure 29: 0.1° at 48 feet is 1.005311 inch.[48feet]





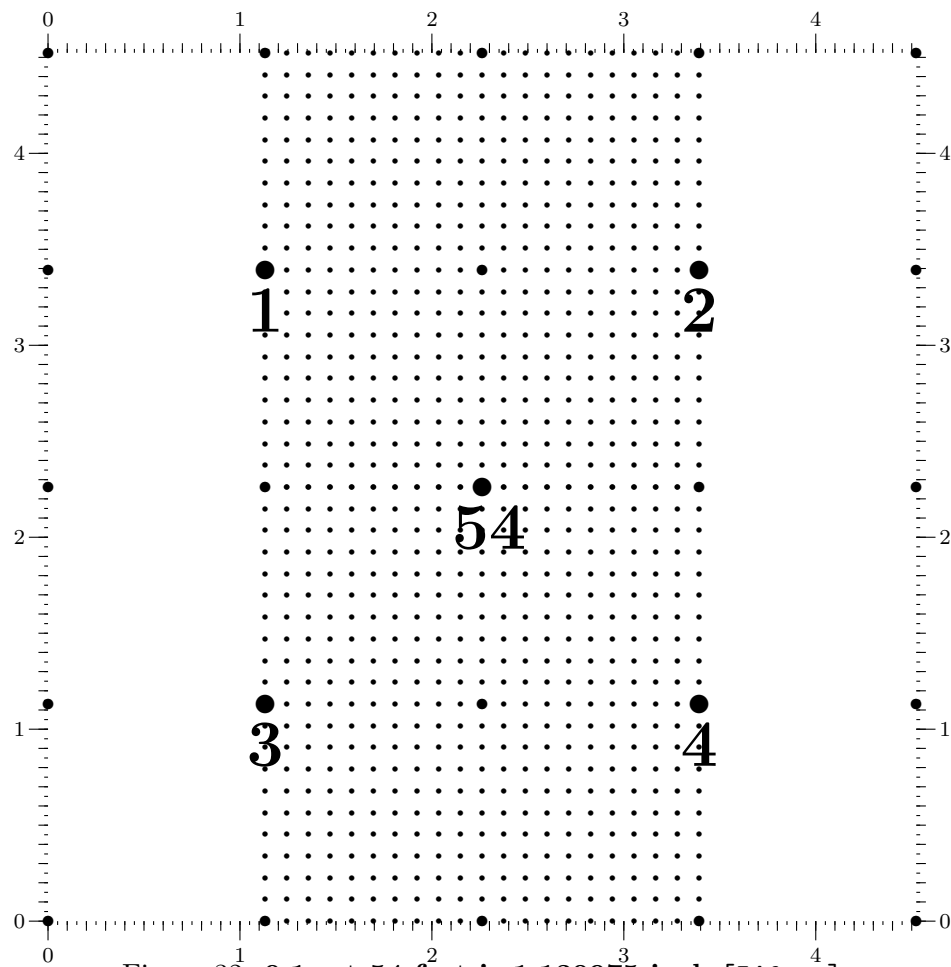
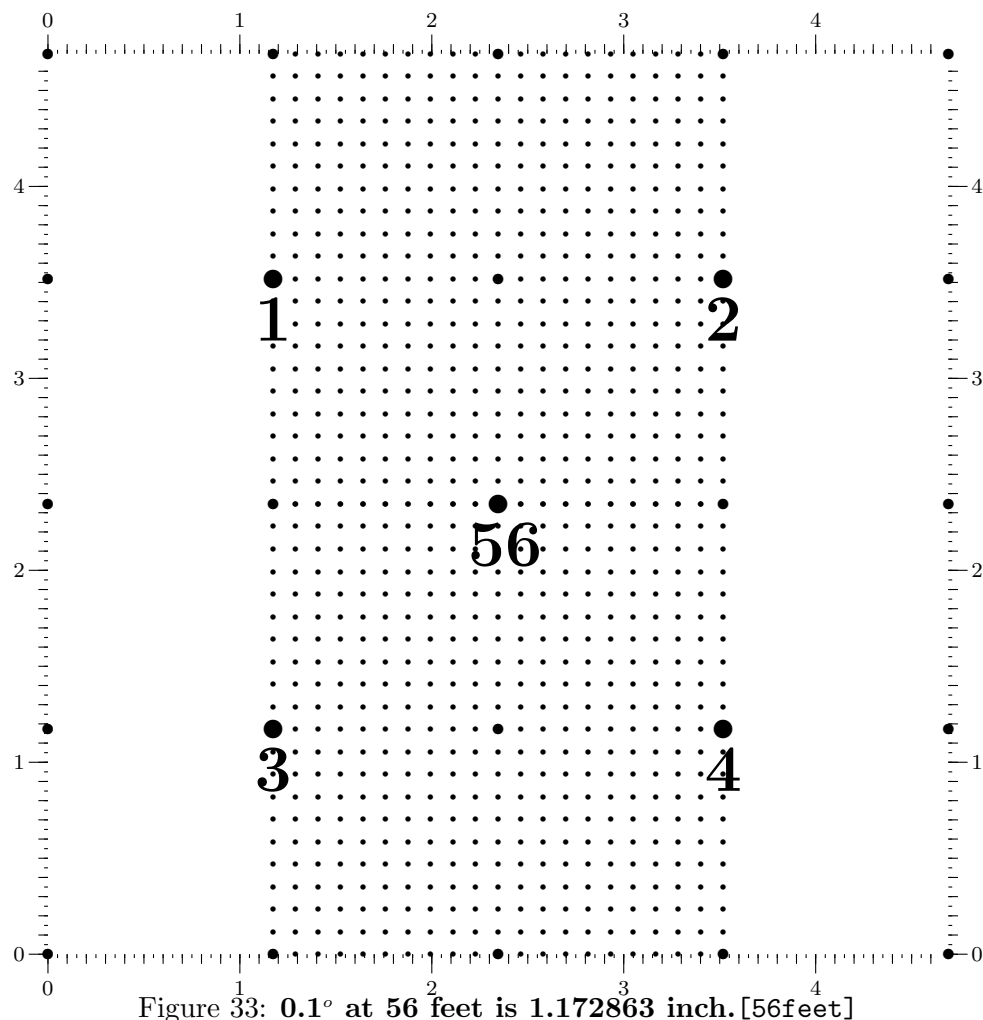


Figure 32: 0.1° at 54 feet is 1.130975 inch. [54feet]



1.3 Metric Calibration Grids

Distance	Page
1.0	Figure 34, page 45
1.5	Figure 35, page 46
2.0	Figure 36, page 47
2.5	Figure 37, page 48
3.0	Figure 38, page 49
3.5	Figure 39, page 50
4.0	Figure 40, page 51
4.5	Figure 41, page 52
5.0	Figure 42, page 53
5.5	Figure 43, page 54
6.0	Figure 44, page 55
6.5	Figure 45, page 56
7.0	Figure 46, page 57
7.5	Figure 47, page 58
8.0	Figure 48, page 59
8.5	Figure 49, page 60
9.0	Figure 50, page 61
9.5	Figure 51, page 62
10.0	Figure 52, page 63
11.0	Figure 53, page 64
12.0	Figure 54, page 65
13.0	Figure 55, page 66
14.0	Figure 56, page 67
15.0	Figure 57, page 68
16.0	Figure 58, page 69
17.0	Figure 59, page 70
18.0	Figure 60, page 71
19.0	Figure 61, page 72
20.0	Figure 62, page 73

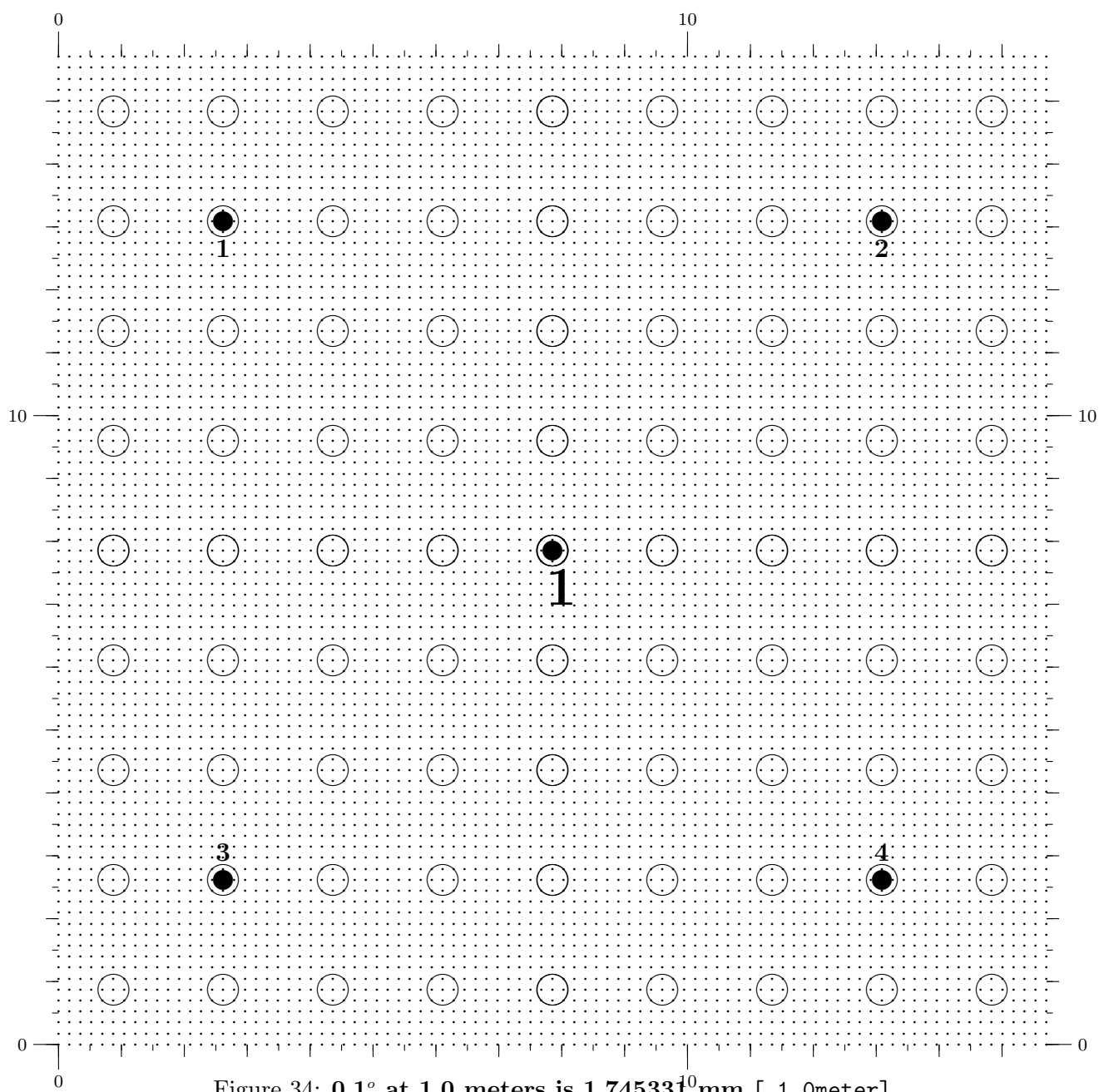
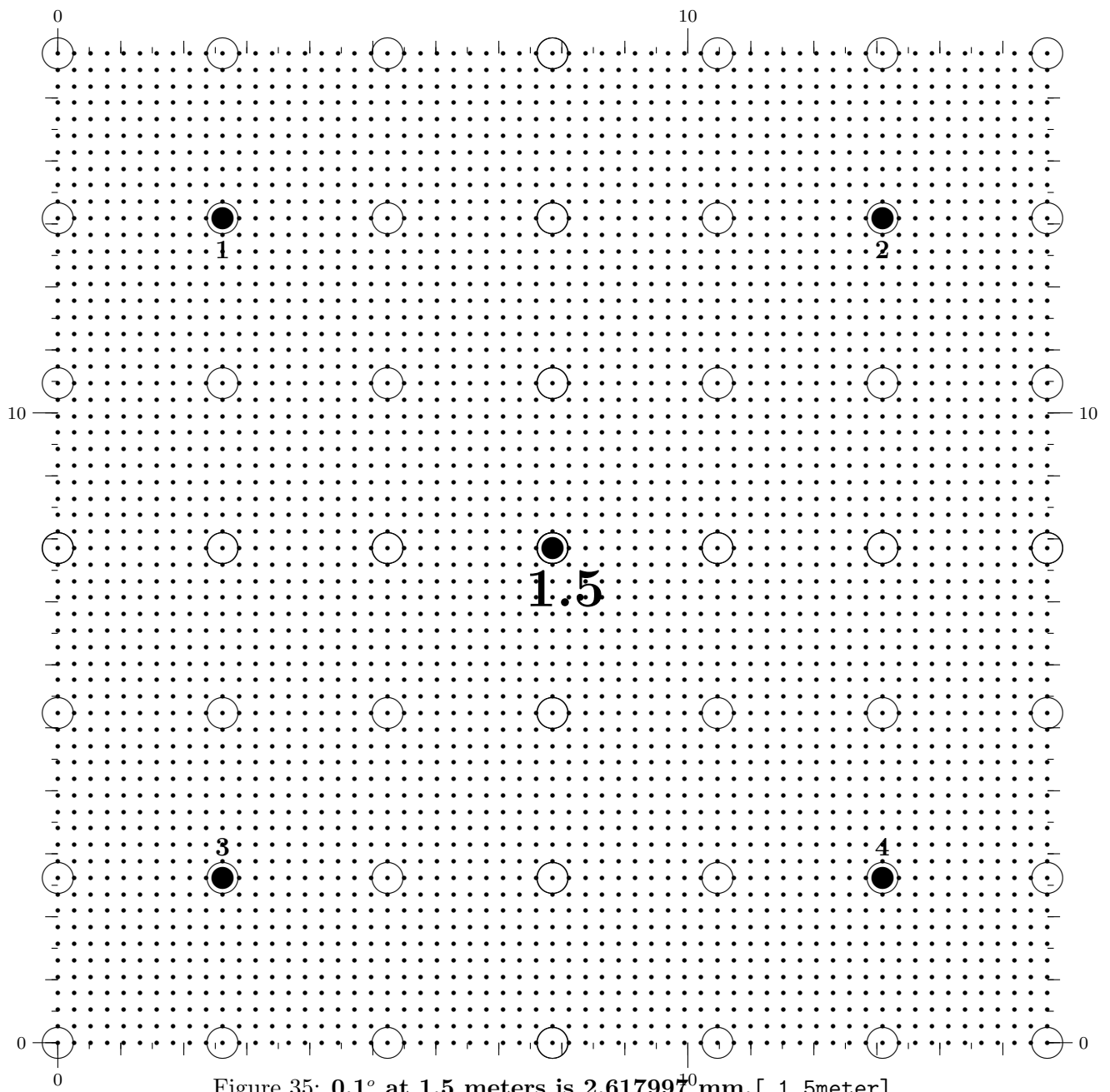
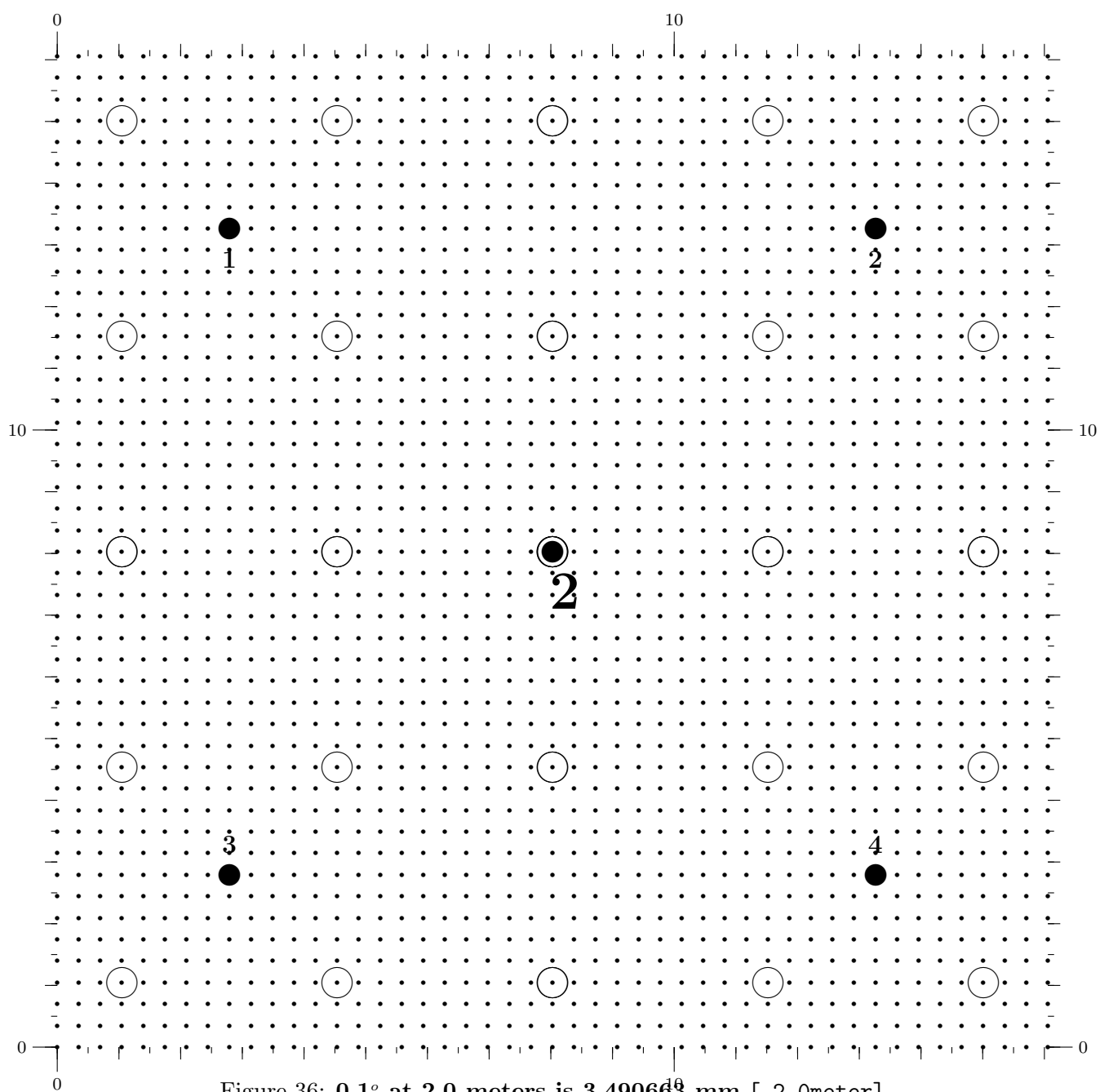
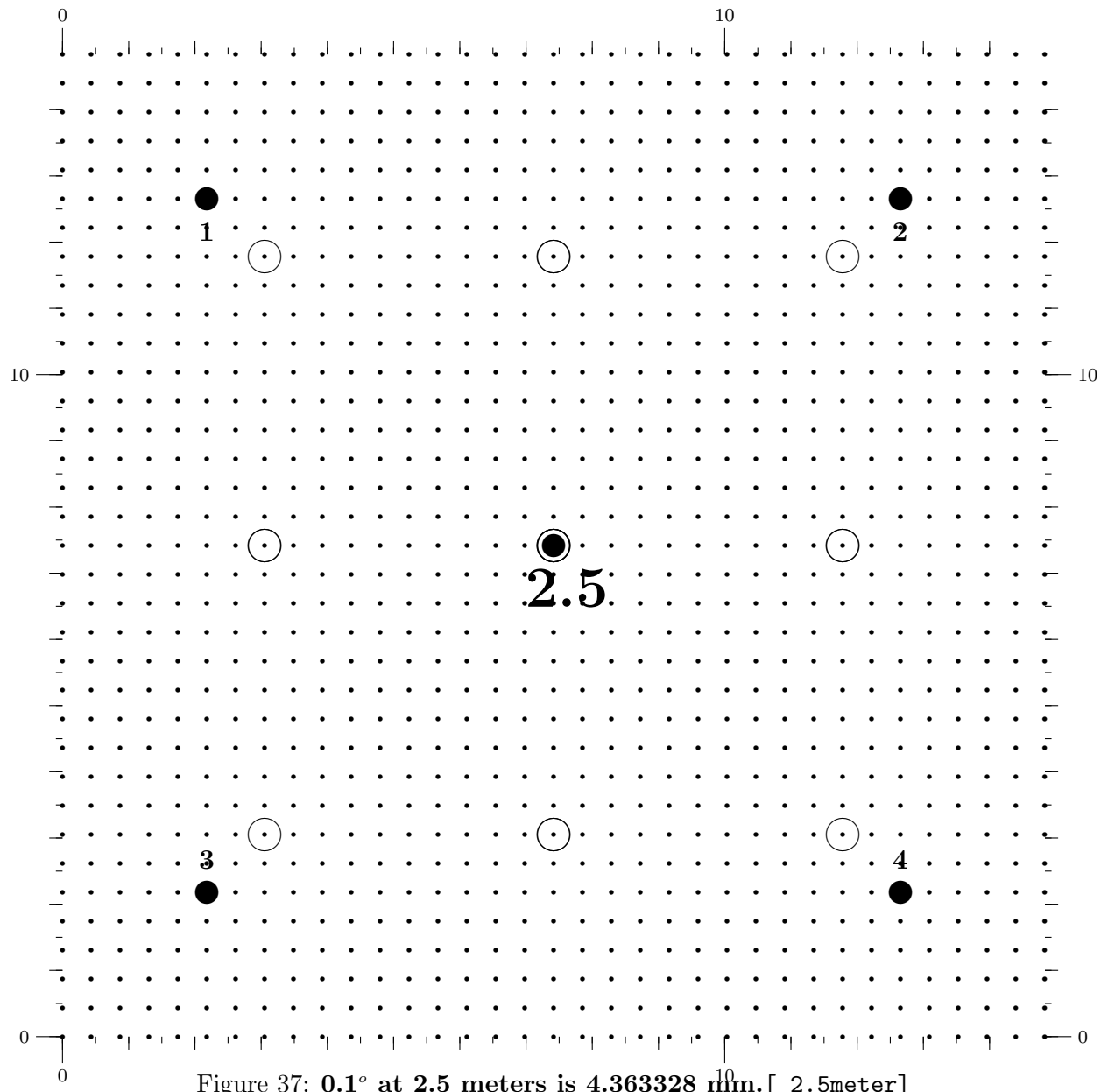
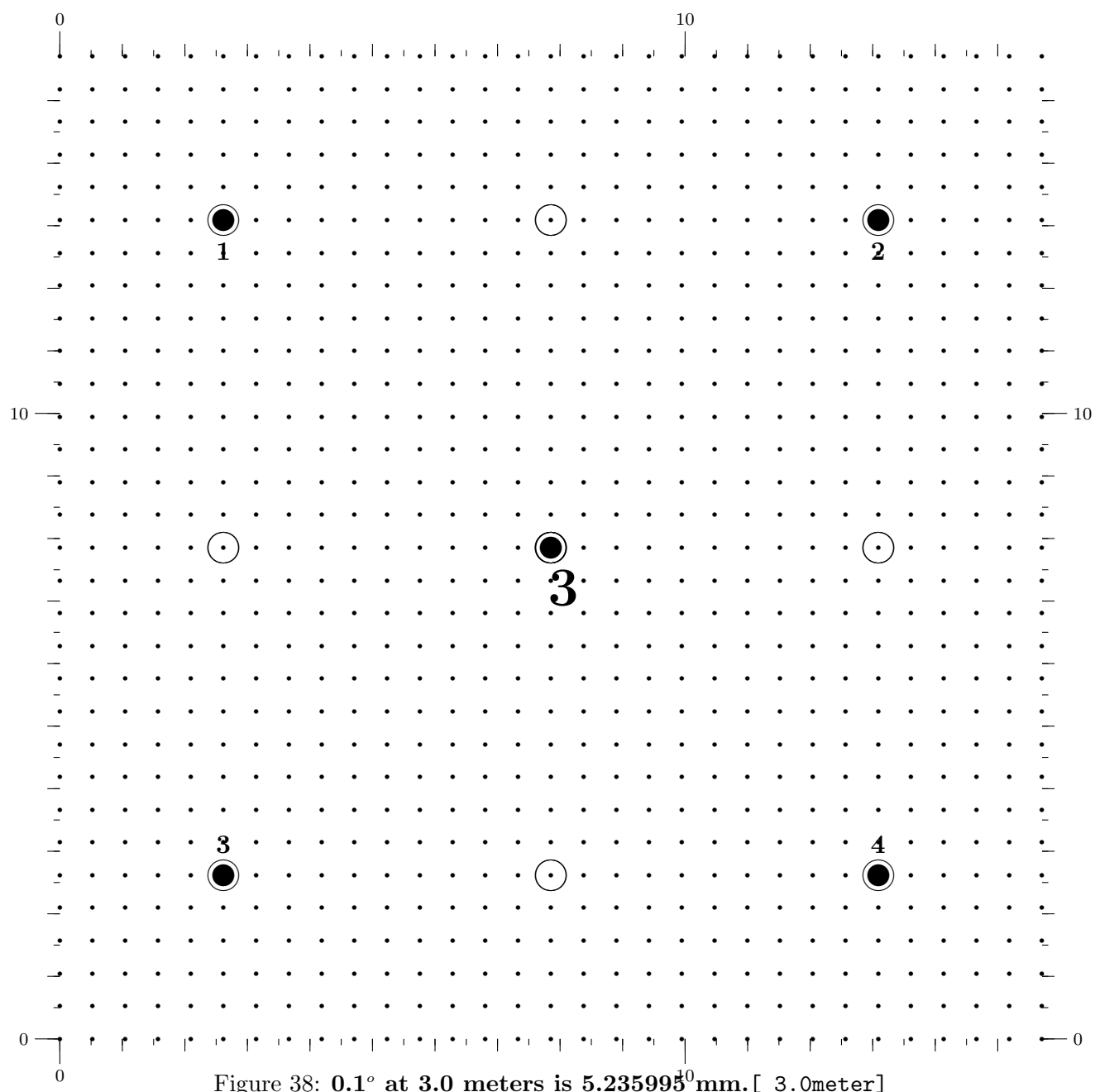


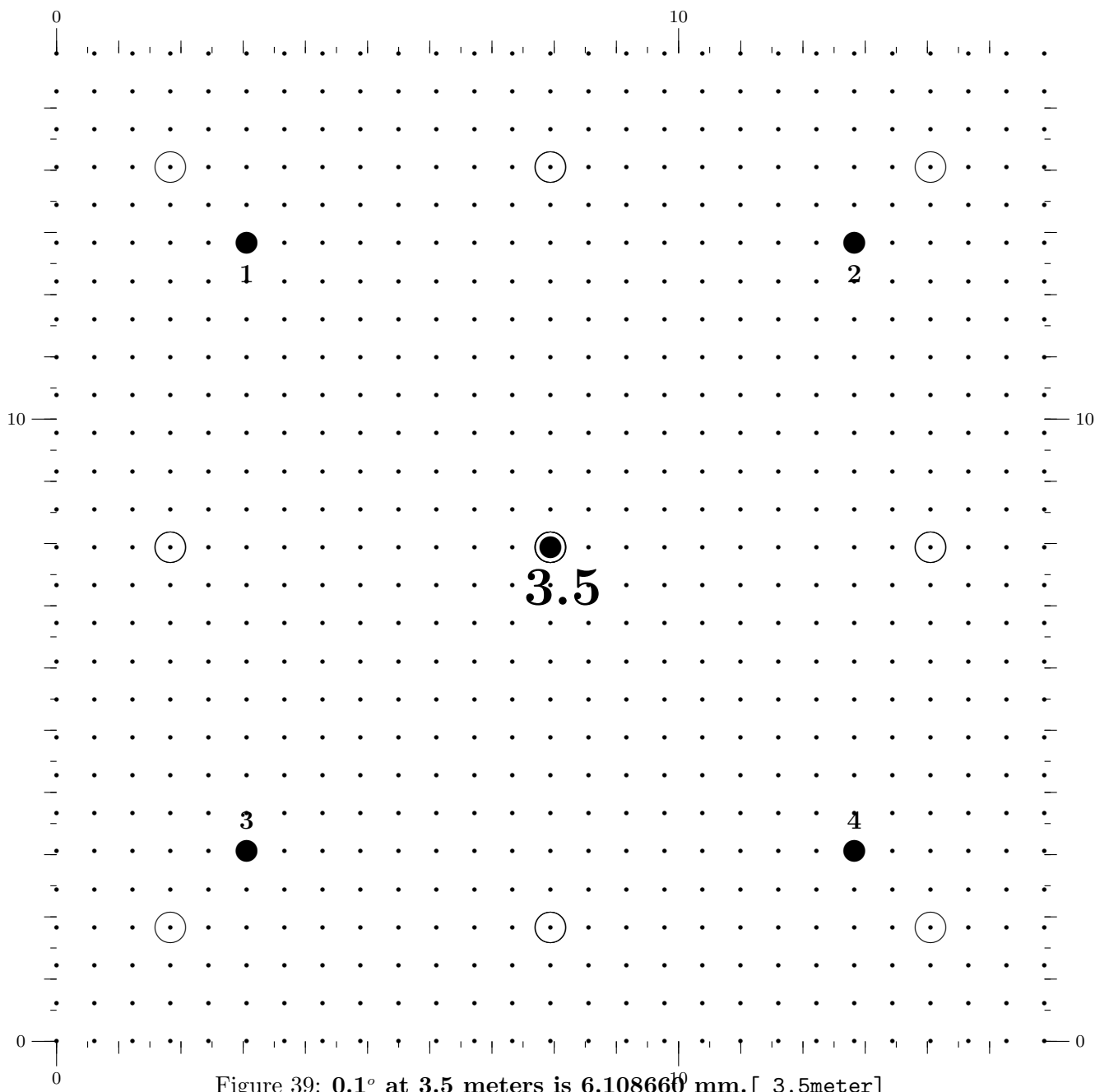
Figure 34: 0.1° at 1.0 meters is 1.745331^{10} mm. [1.0meter]

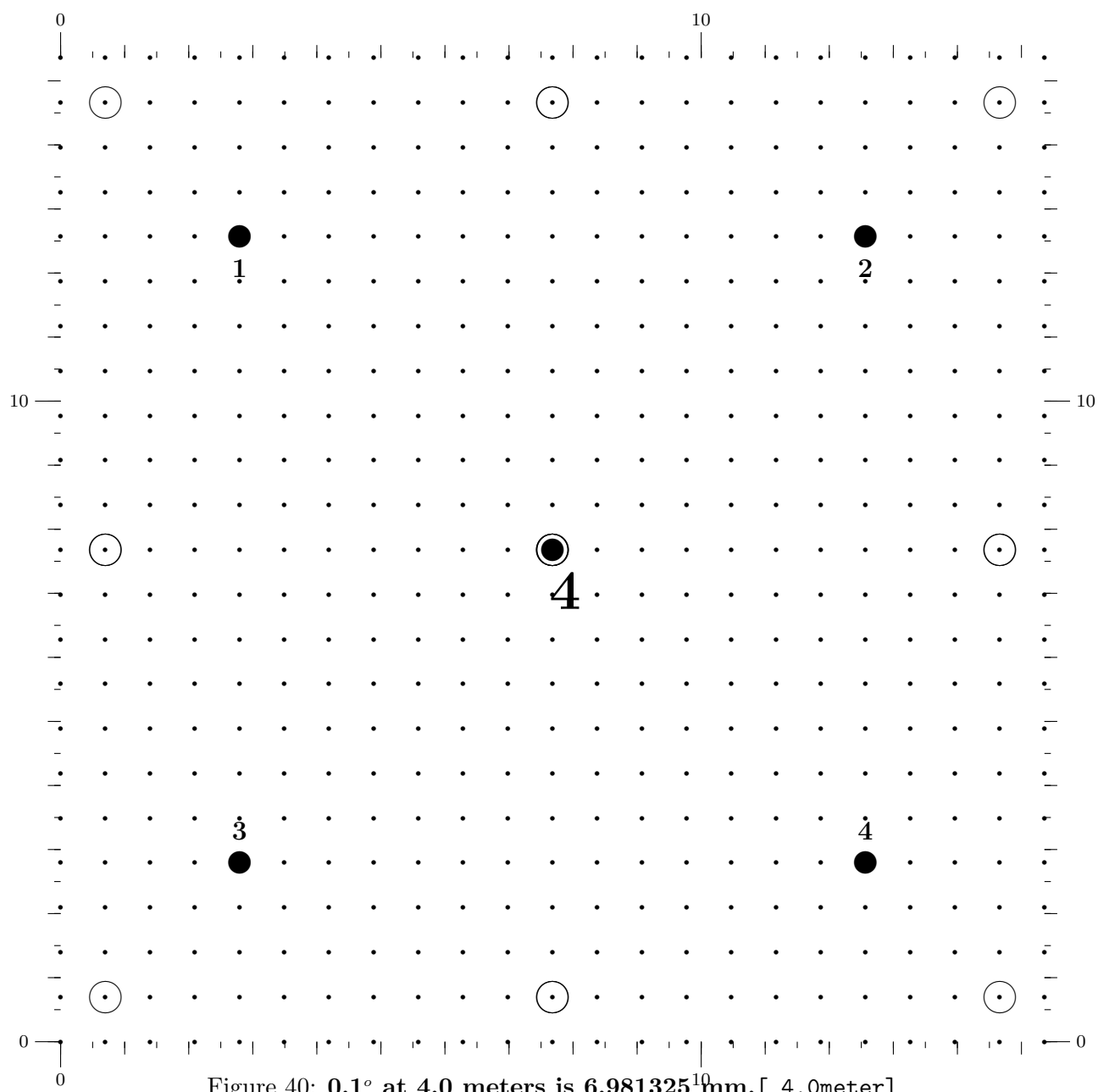


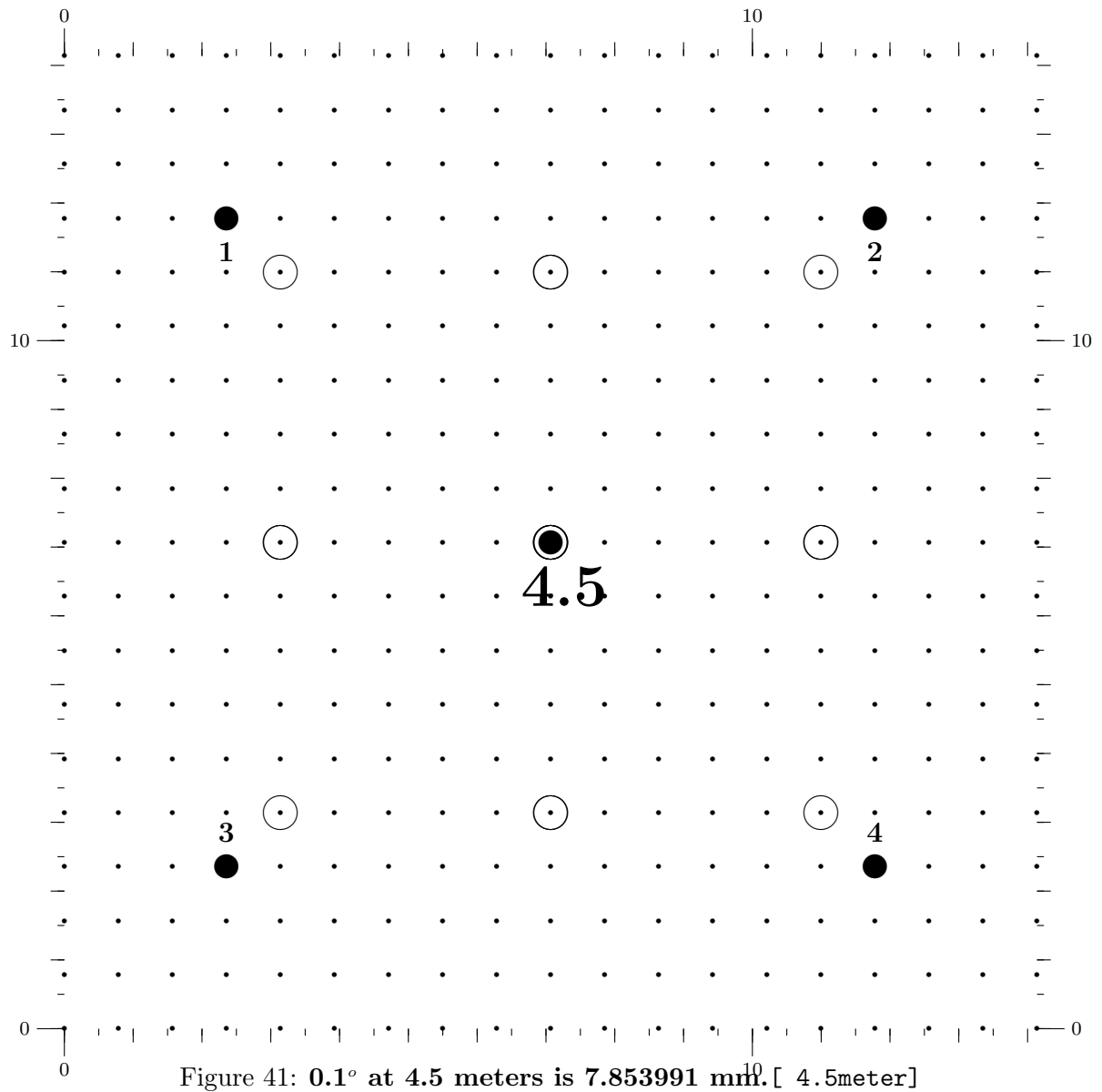


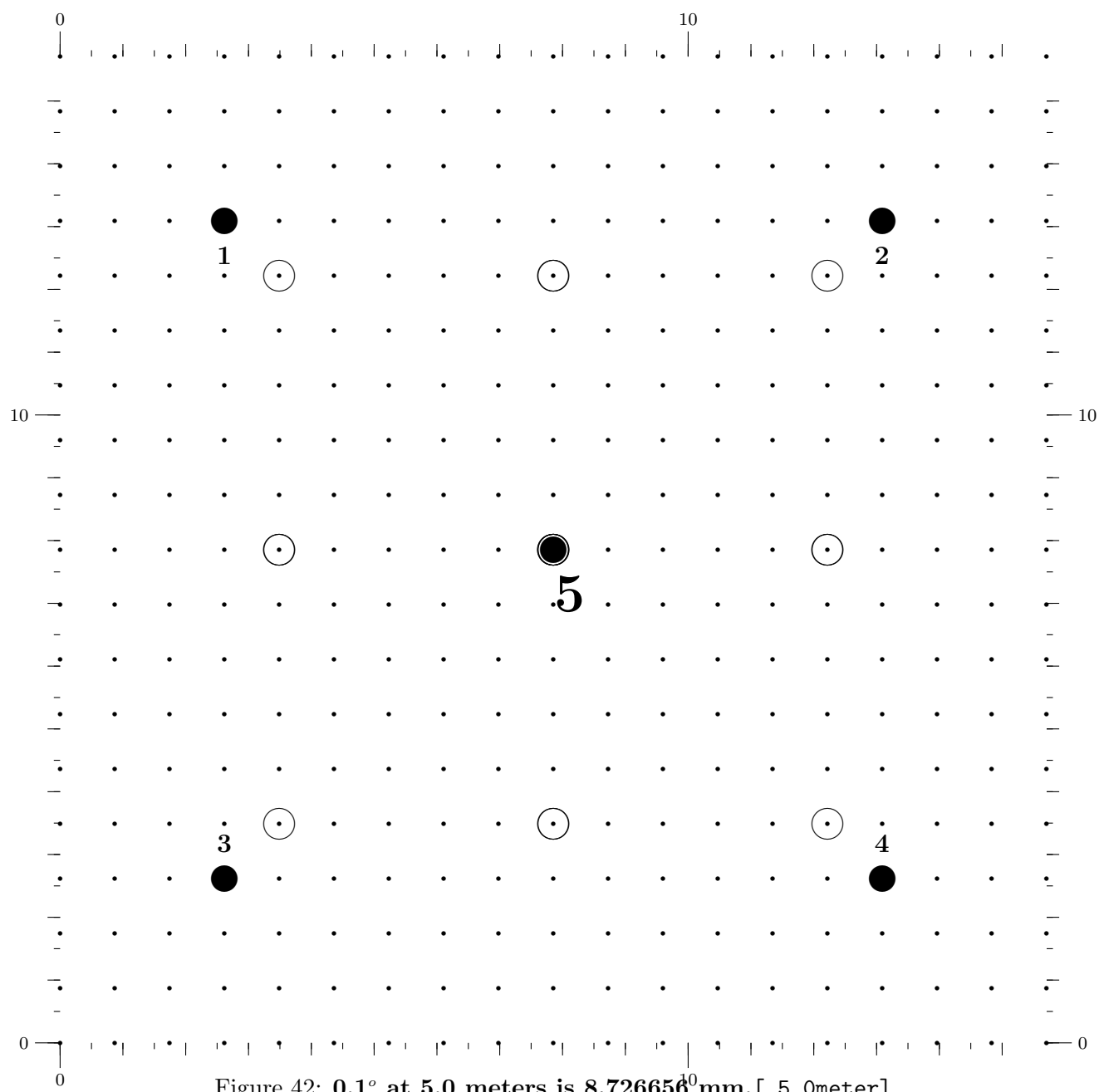


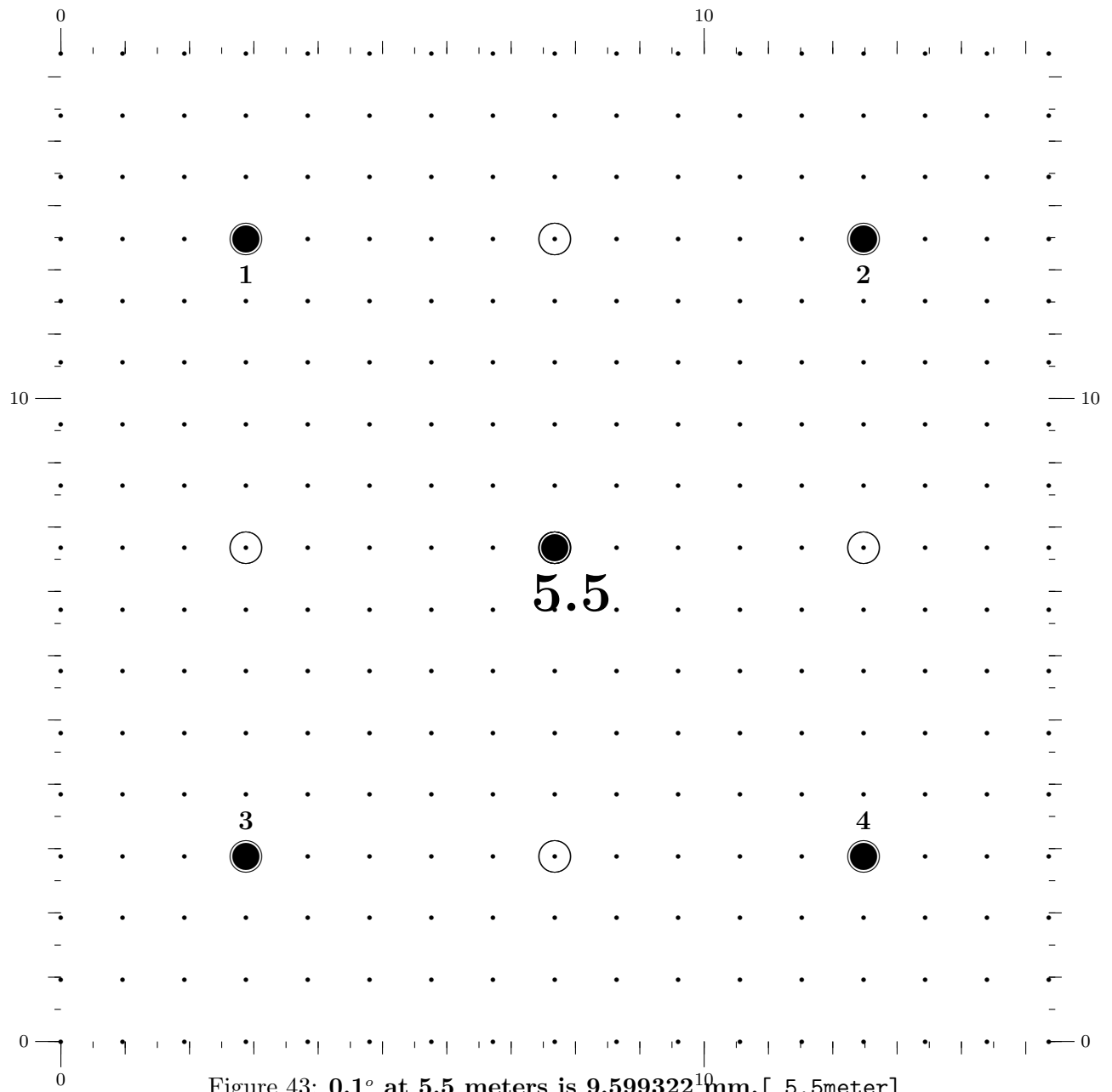


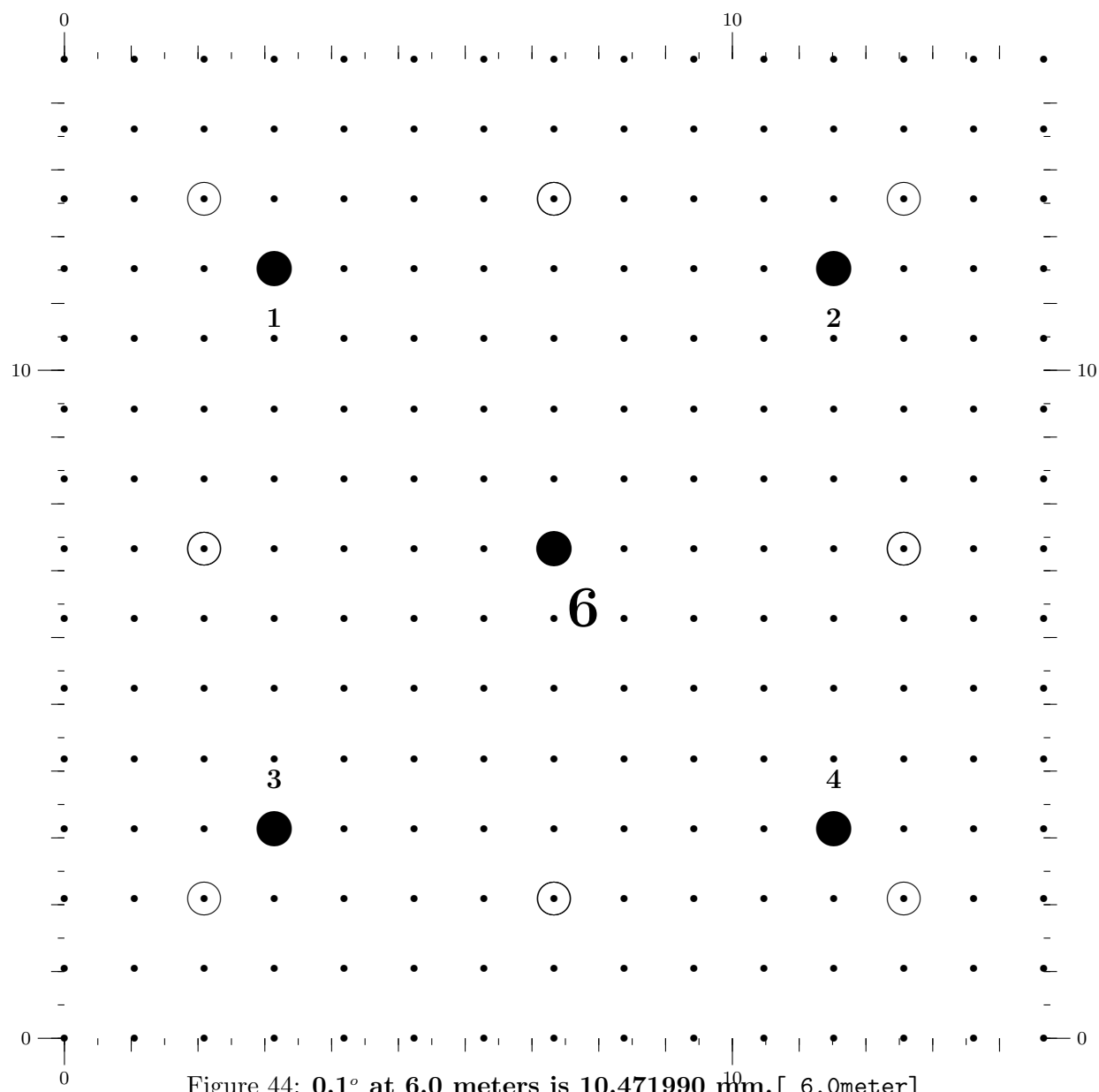


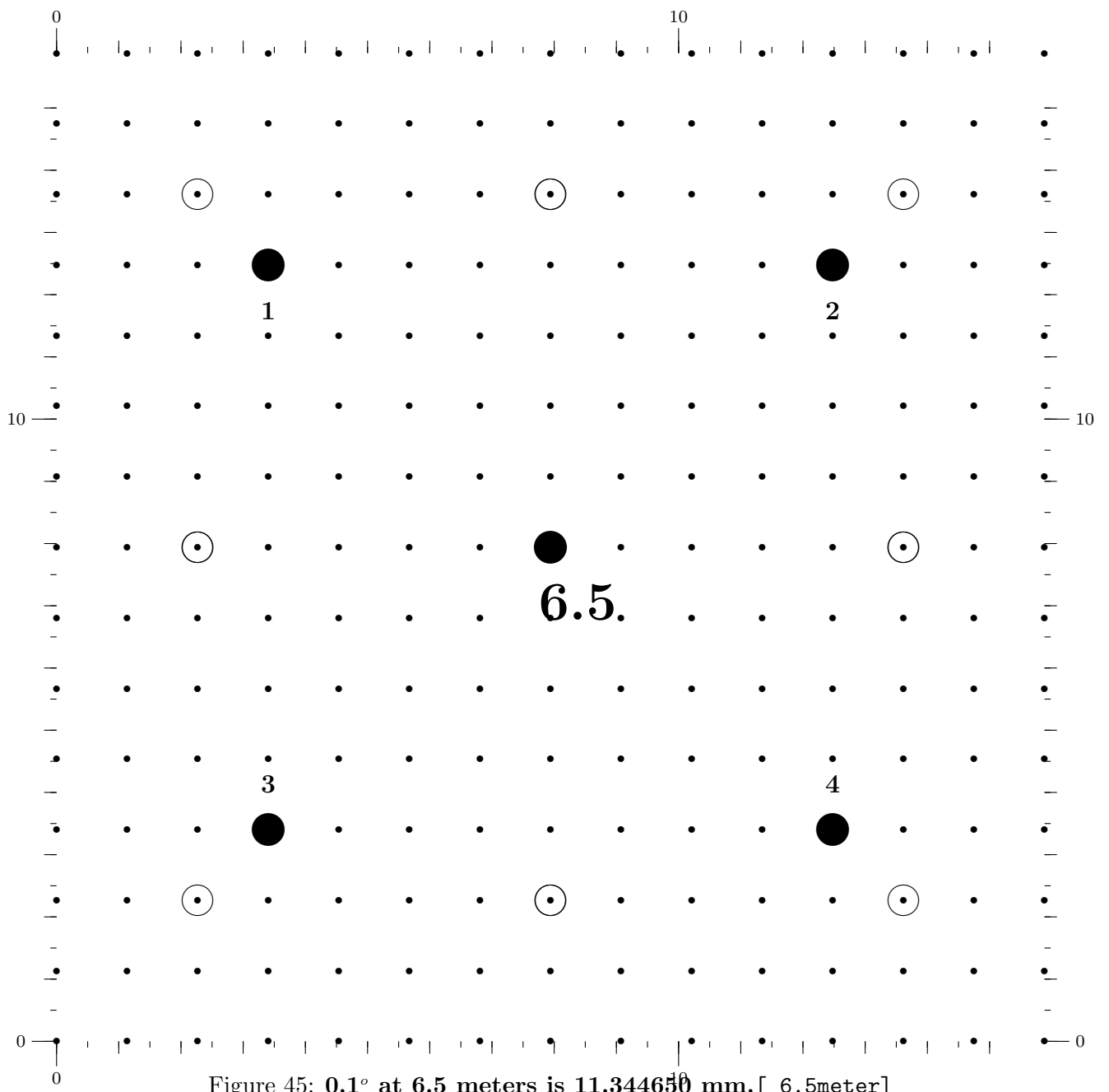


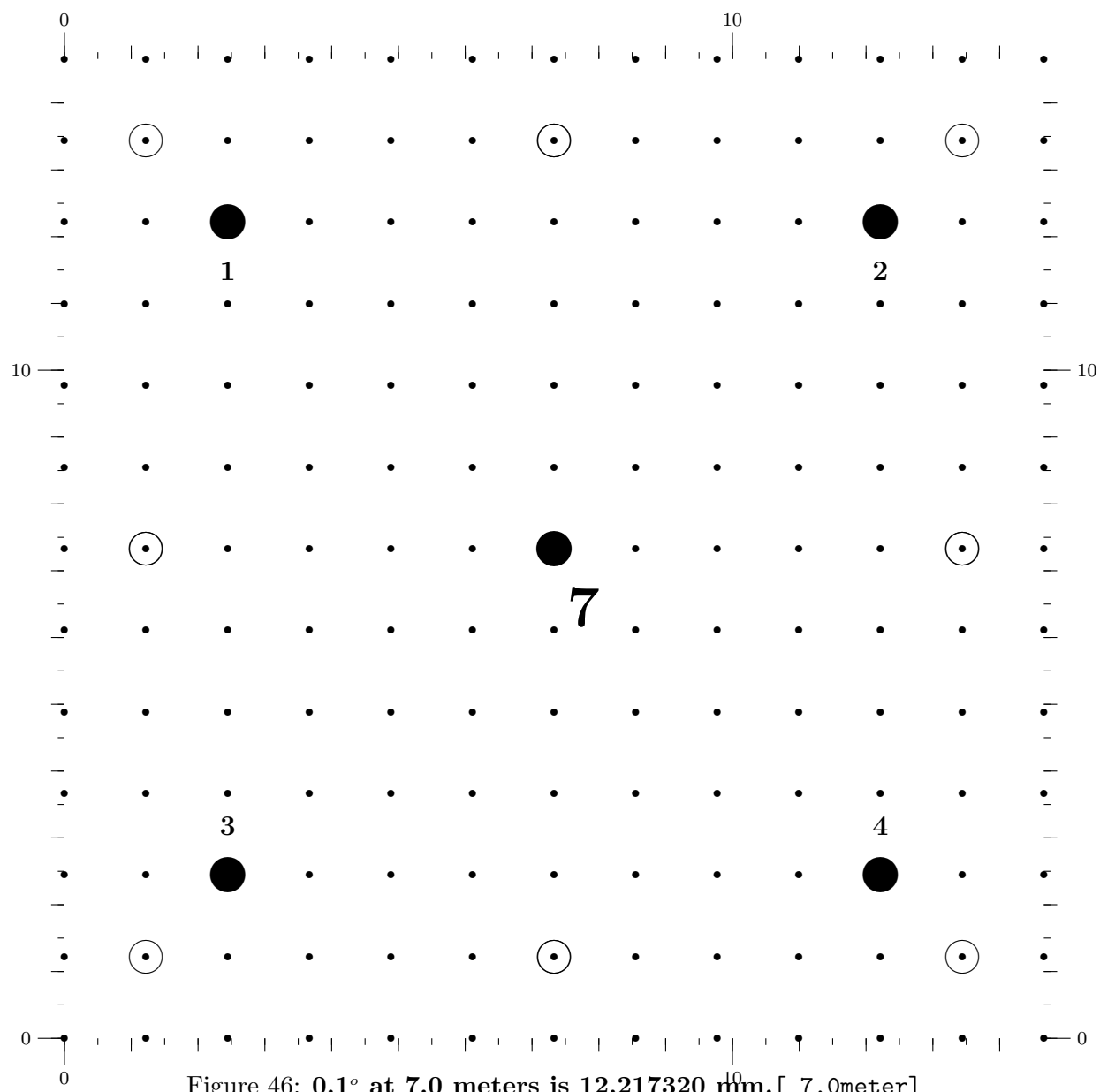


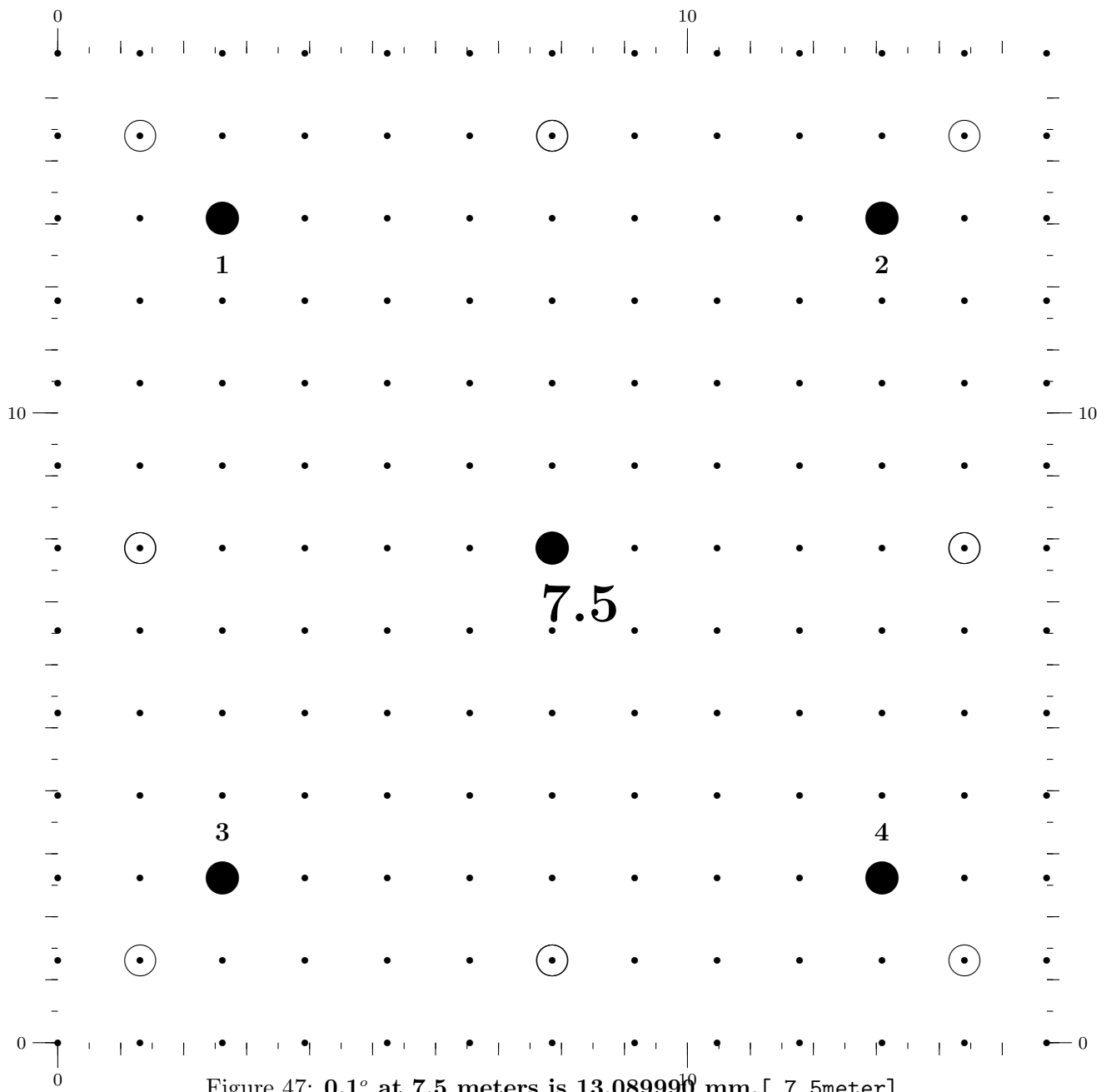


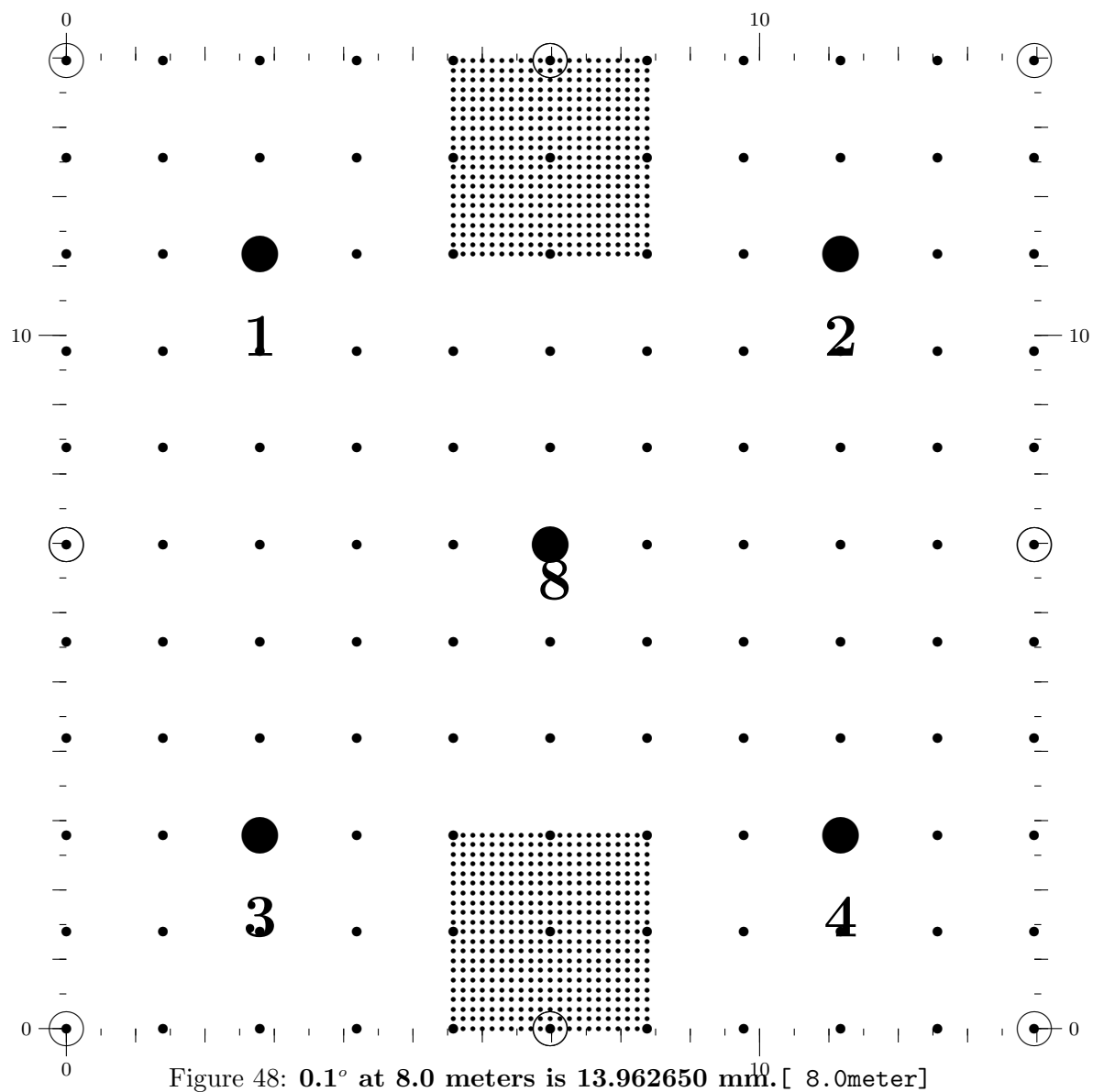


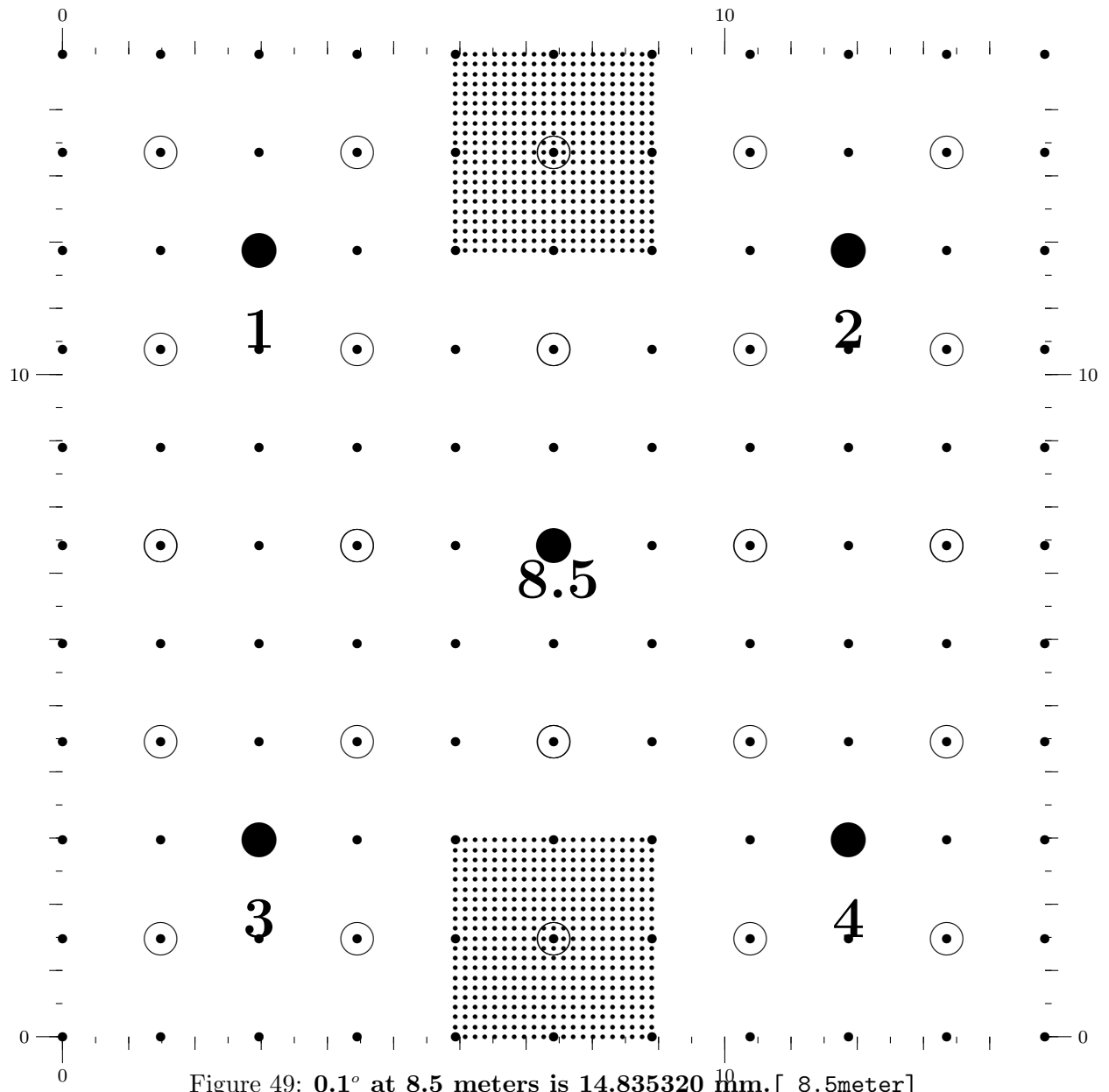


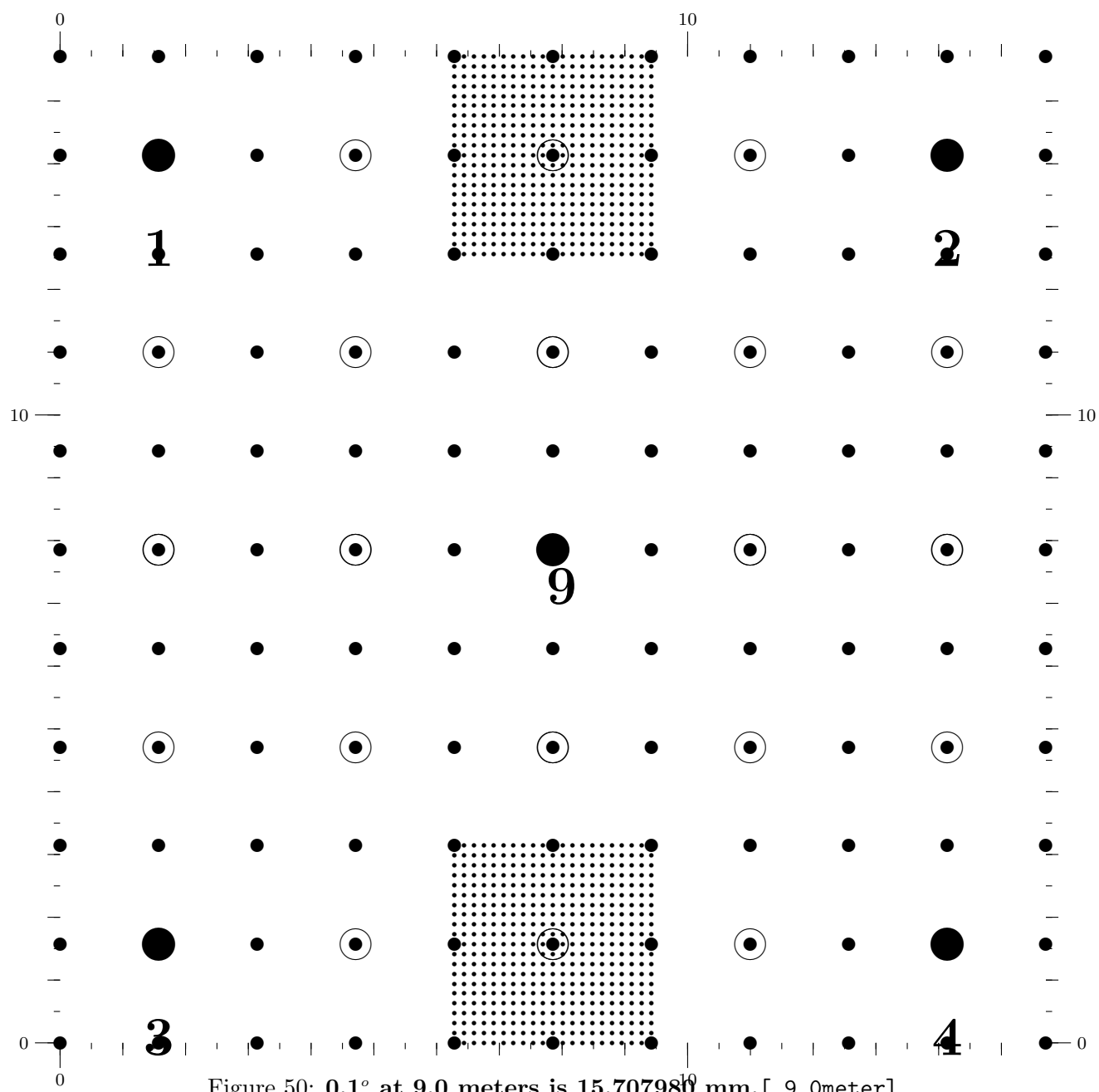


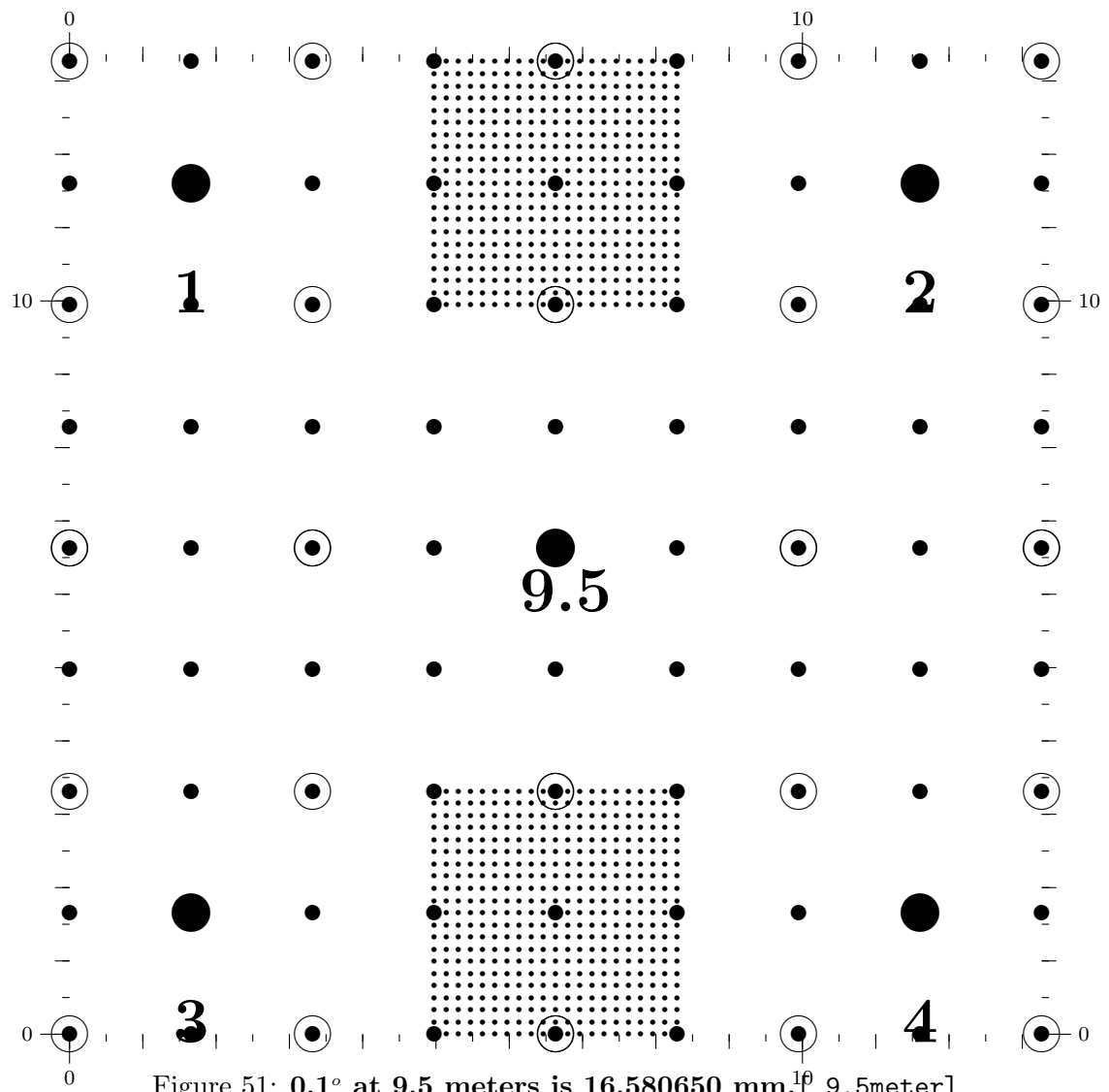


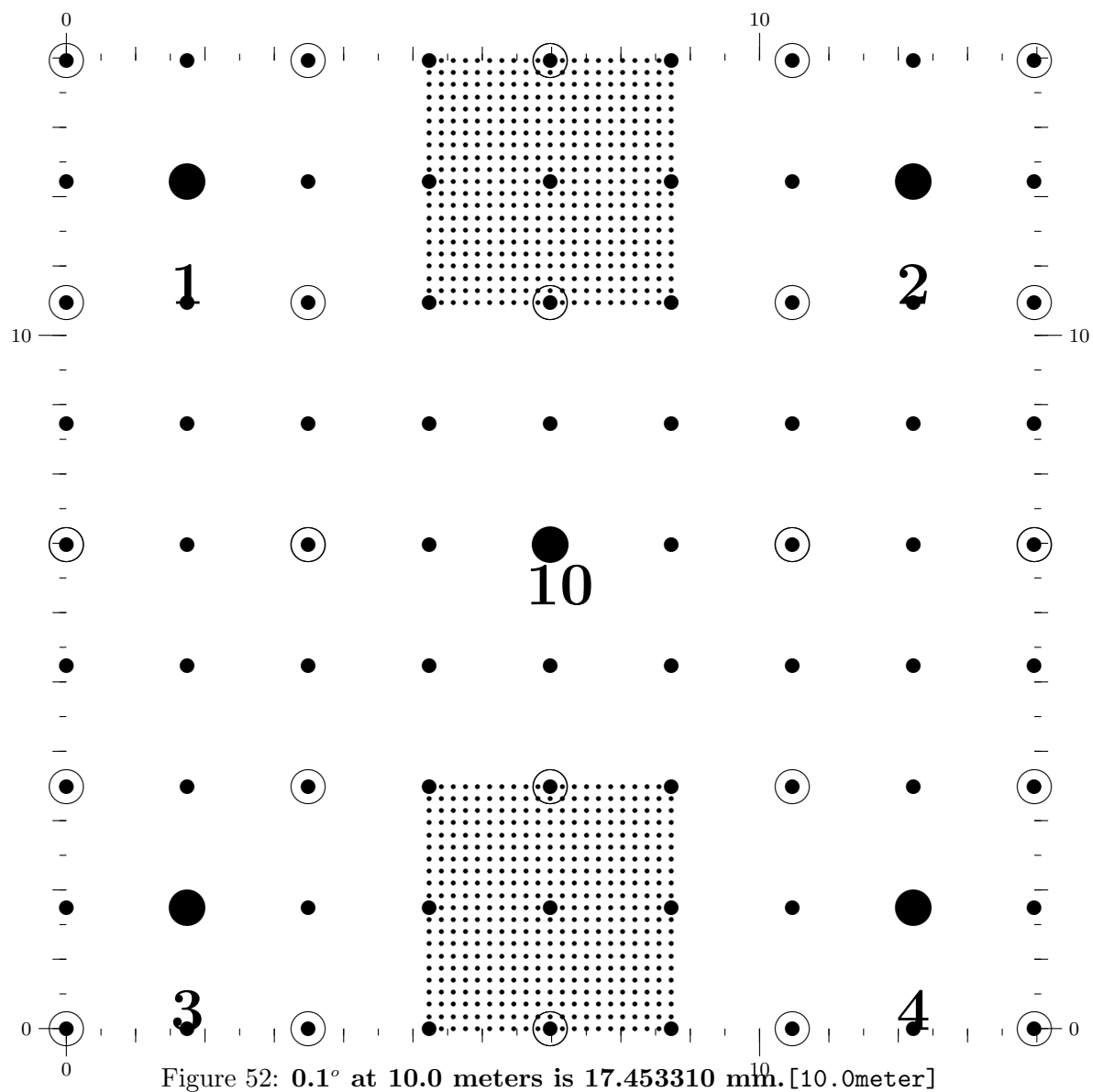


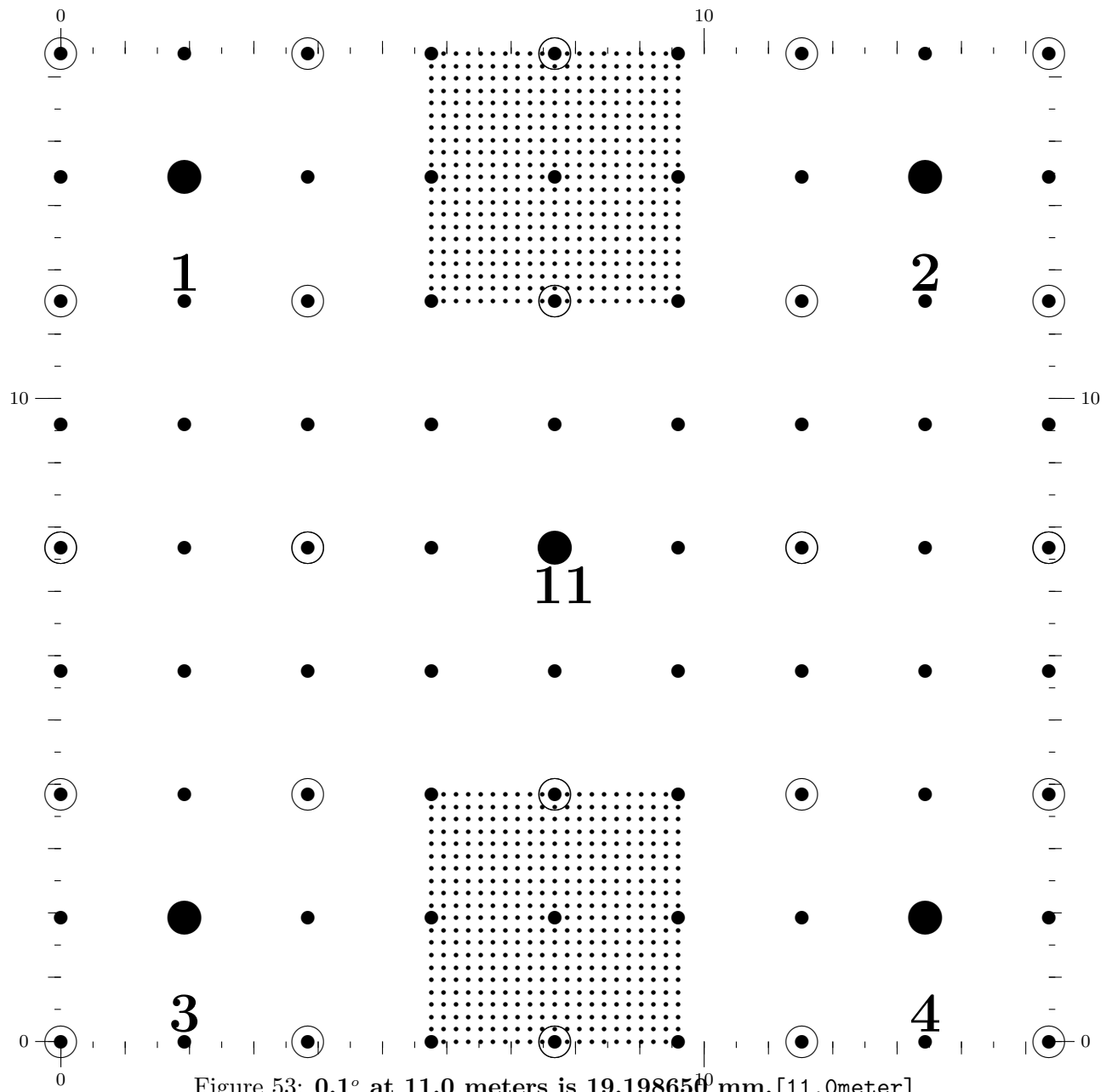


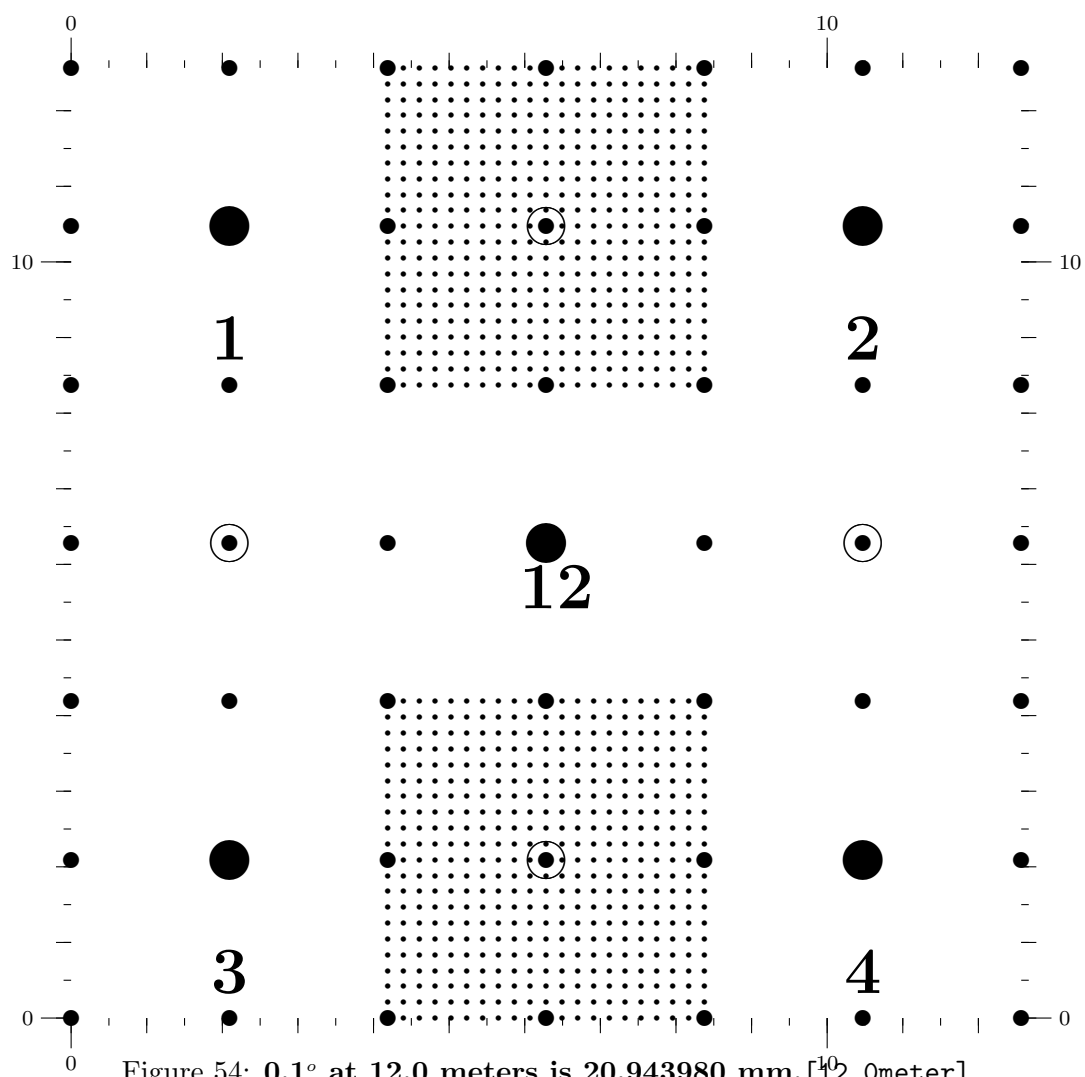


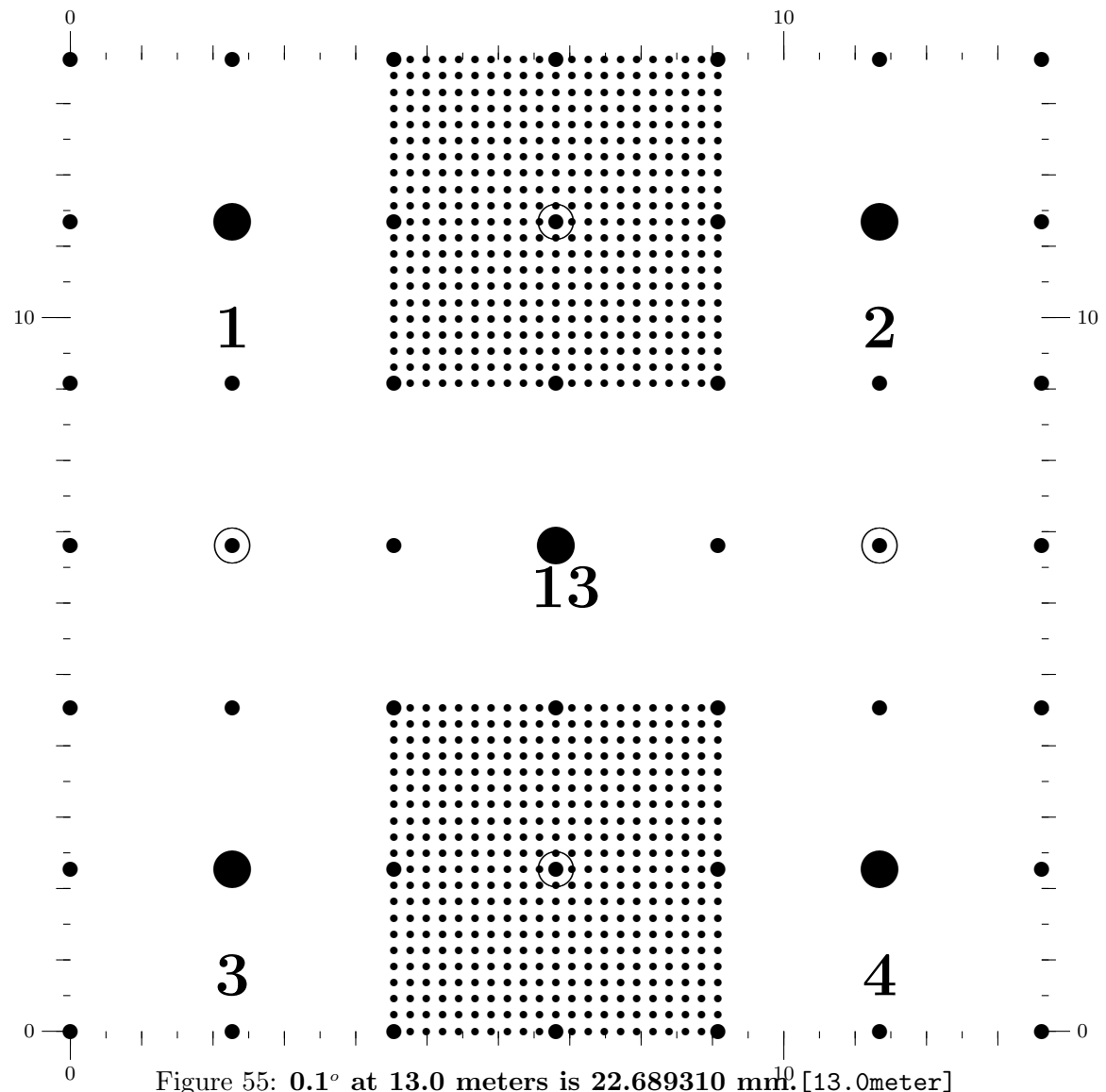


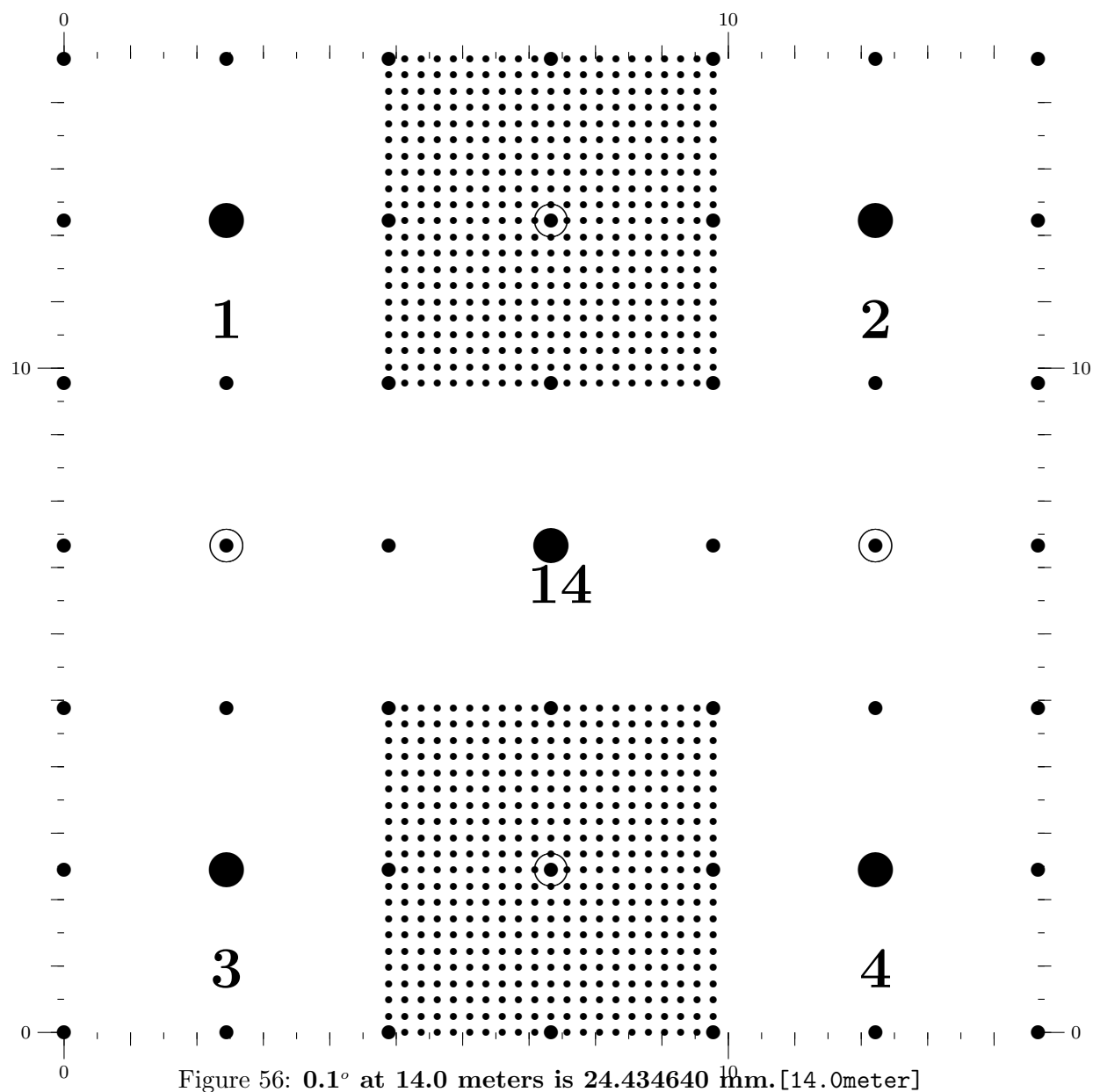


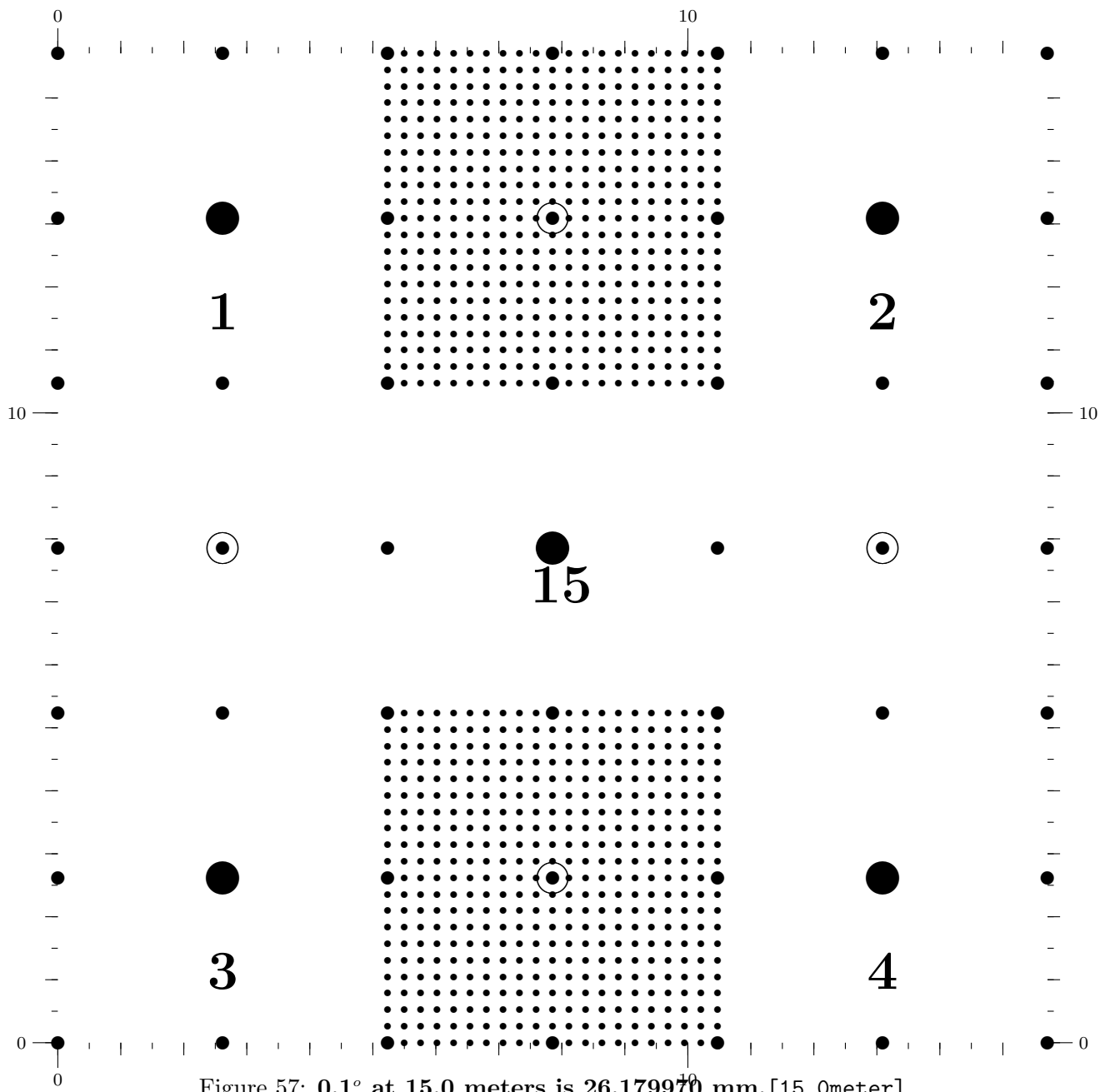












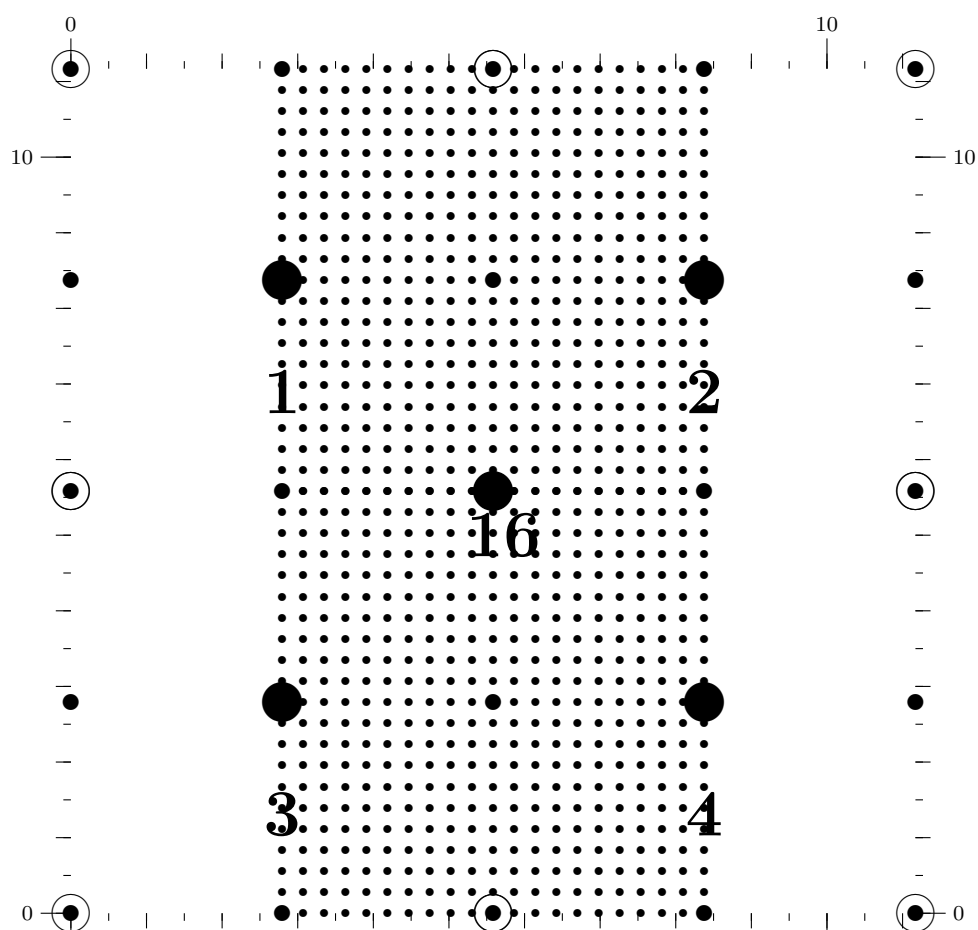
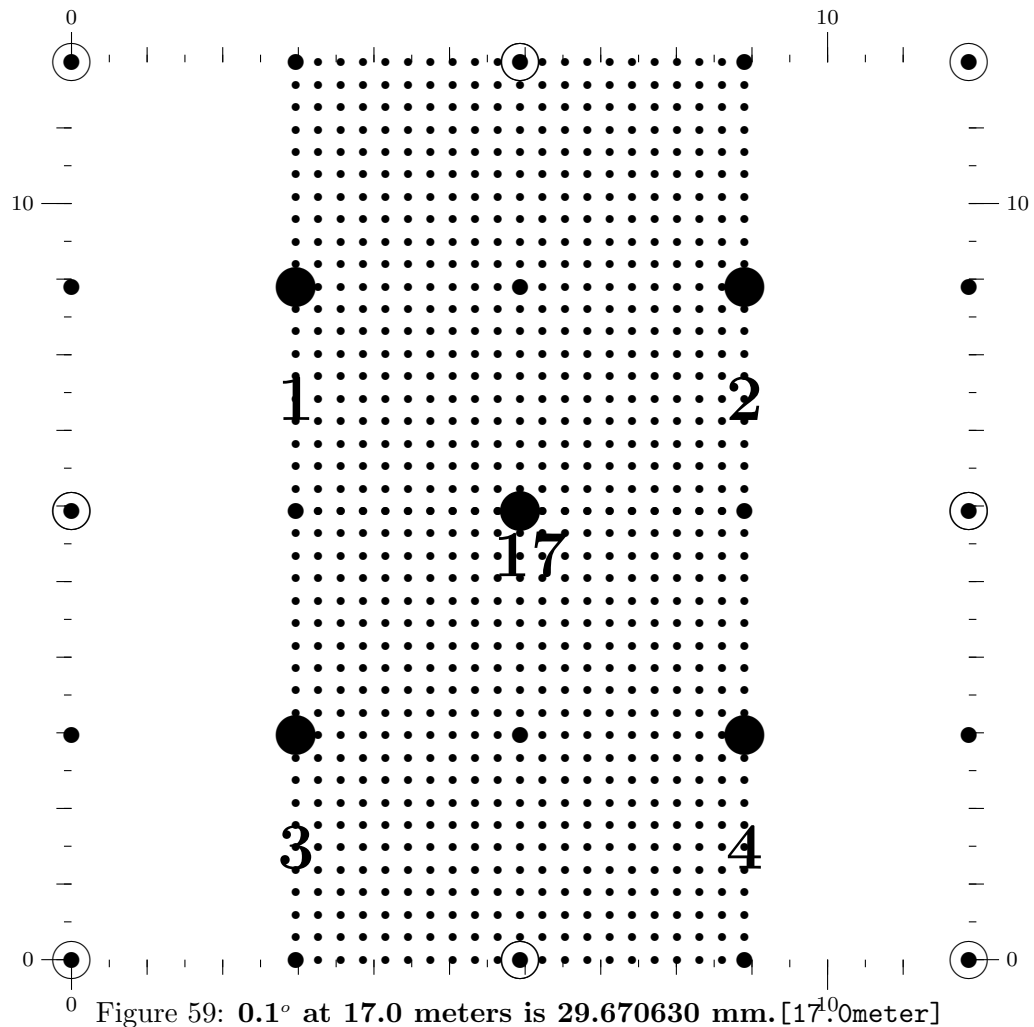
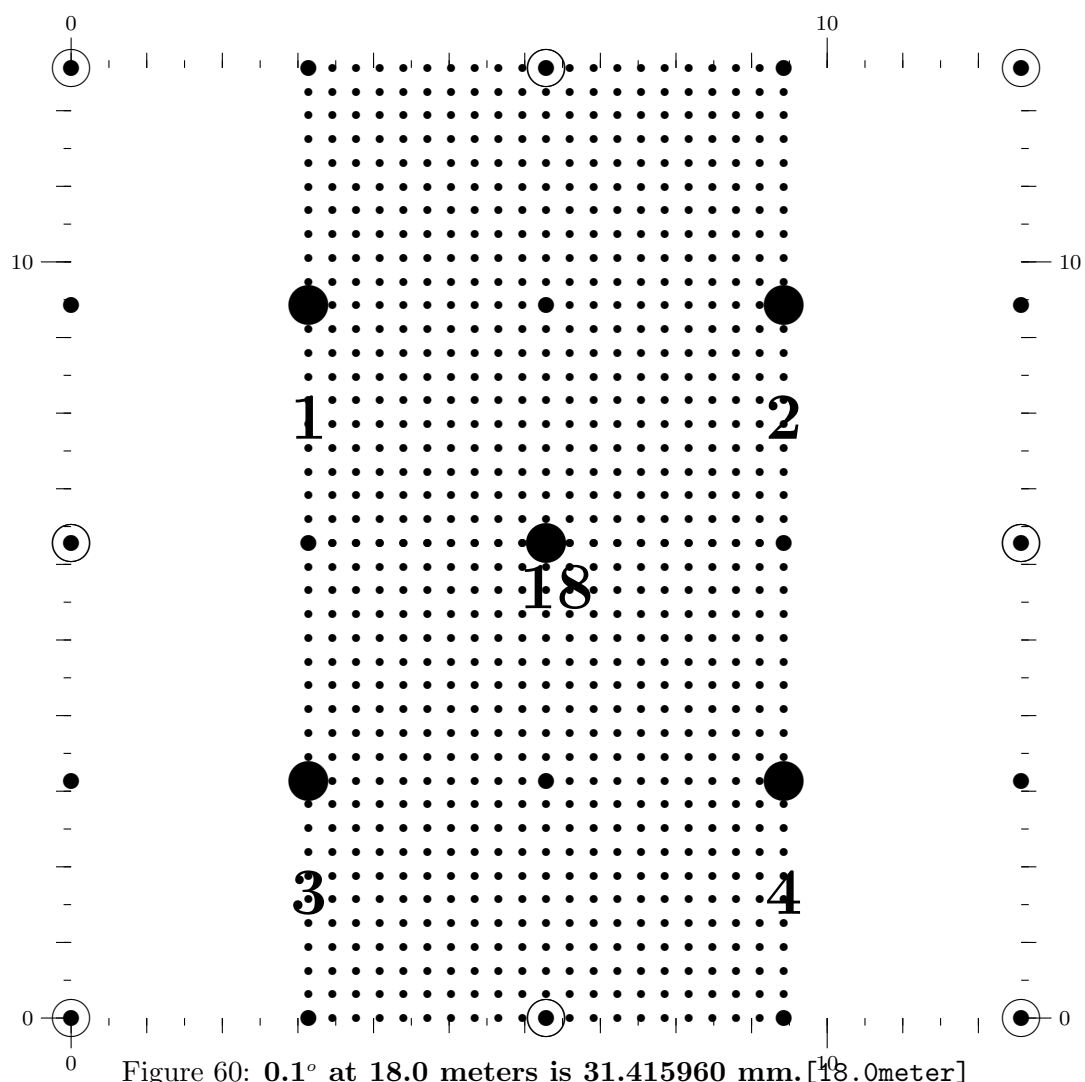
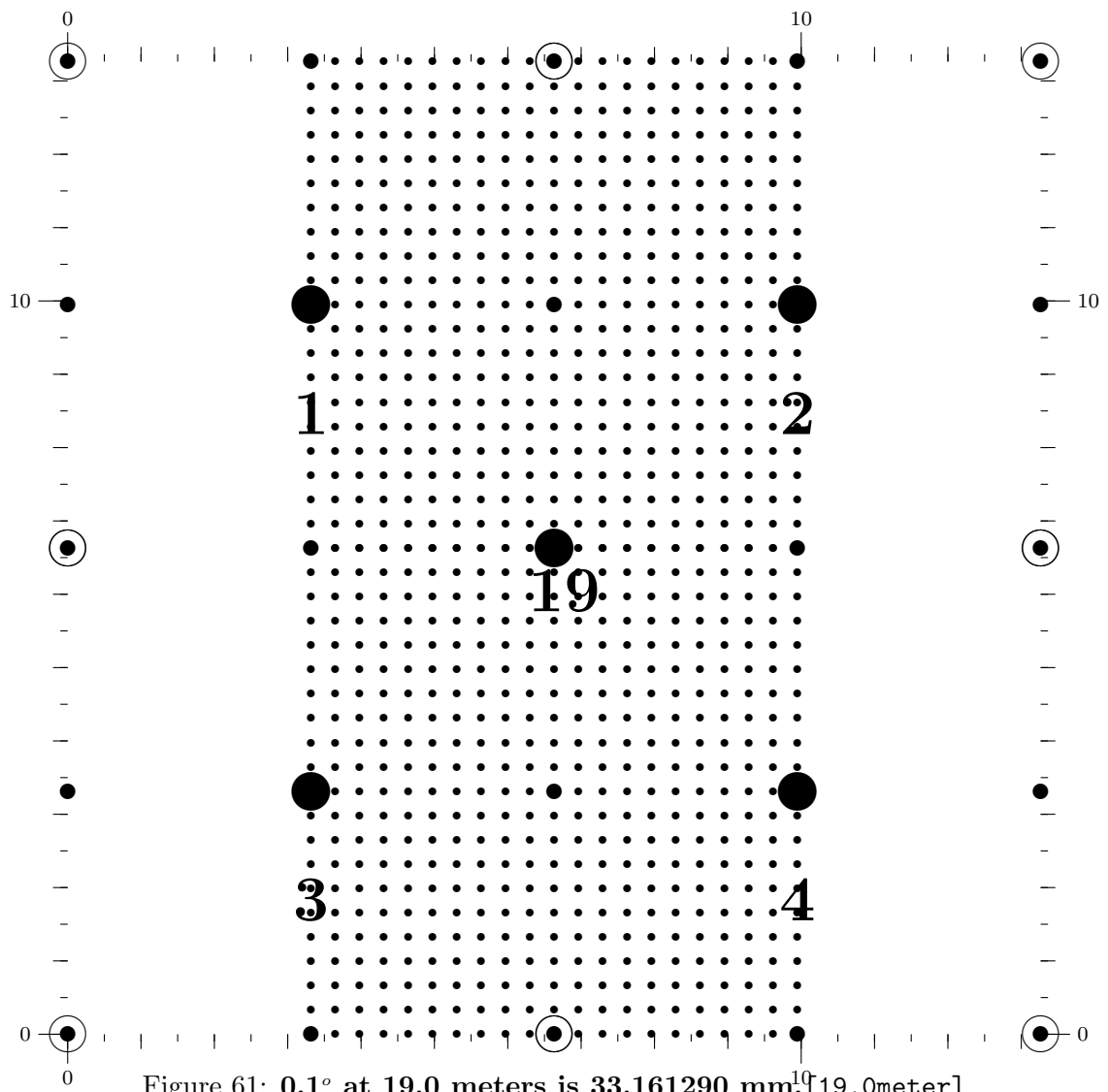
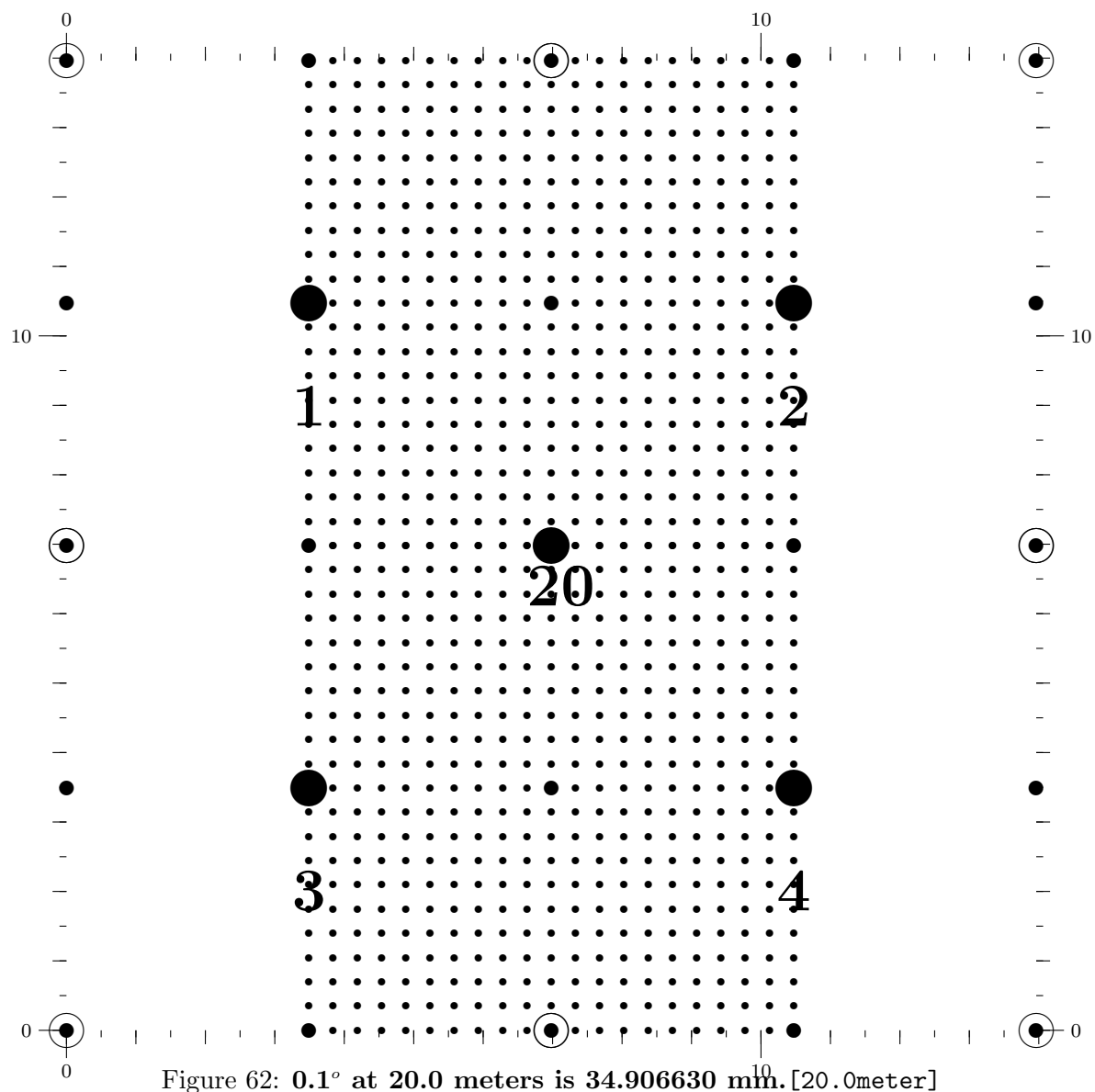


Figure 58: 0.1° at 16.0 meters is 27.925300 mm. [16.0meter]









1.4 TgtGen.bas Routines

A short program written in GW-BASIC was developed to generate the L^AT_EXplot files used in making the actual targets. Here they are. *These have been temporarily deleted.*