

Pic2Mag Science Fair

User Manual for the Pic2Mag Science Fair app

Transform hand-drawn pictures of magnets into accurate magnetic-field maps — isolines, vector arrows, then print the results for students to take home.

© 07/30/2026 Michael Snyder (Pic2Mag). All Rights Reserved.

The Pic2Mag family of programs are now a free download.

For the latest version, visit the Microsoft Store page for Pic2Mag Science Fair.

Table of Contents

- 1. Teacher Science-Fair Workflow
- 2. Professional Drawings with Extended Colors
- 3. The Ferrocell Easter Egg
- Appendix A. Complete Color Reference Table

1. Teacher Science-Fair Workflow

1.1 What Pic2Mag Science Fair does

Pic2Mag Science Fair is a Windows app that turns a drawing into a scientific map of a magnetic field. Students draw with red and blue markers on ordinary paper. The teacher scans or photographs the stack of papers, and the app produces a colorful printout showing the invisible field around the magnets the students imagined.



Figure 1. A busy science-fair booth. Students draw with red and blue markers, scanner and printer prepare take-home field maps.

1.2 What you need for a class

- A Windows 10 or Windows 11 computer.
- A flatbed scanner or a webcam for importing the drawings into the app.
- A printer (any ordinary inkjet or laser printer works).
- Red and blue markers. CraZArt markers were used for the original test images.
- Blank white paper.

1.3 The main screen

The app opens to a three-zone layout. The large center panel shows the current 1280×1280 image. The left (blue) panel holds the four ways to bring a picture in: Scan, Draw, Camera, and Load. The right (yellow) panel holds the processing, plotting, and print settings. The middle (green) panel holds Process, Plot ISO Lines, Plot Vectors, Show ISO & Vectors, and Save.

You can zoom into the center image with the mouse scroll wheel or a pinch gesture, and drag to pan. After seven seconds of inactivity the view snaps back to normal, so the next student always sees the whole picture.

1.4 Kids Mode and General Mode

The yellow panel has a Kids / General toggle. For a classroom or science fair, leave it on Kids Mode. In Kids Mode the app recognizes twelve basic magnet colors (red, blue, and the eight clock-face colors plus two electric modes). This keeps the workflow simple and error-free for young students.

General Mode is for experts who want to use the full 360-degree extended color palette described in Section 2.

1.5 The four ways to get a drawing

Scan — processing a stack of papers

1. Place a student drawing face-down on the flatbed scanner.
2. Tap the Scan button. The first time you scan, the app asks you to pick the scanner and the printer.
3. The app reads the drawing, keeps only red and blue pixels, and displays it in the center panel.
4. If Auto-print is on in the yellow panel, the app immediately processes the drawing and sends a white-background print to the printer.
5. Lift the scanned paper, place the next one, and tap Scan again. The app numbers each output automatically: Class_001, Class_002, and so on.

Auto-print is the fastest way to run a booth. Once it is enabled, the teacher only has to press Scan button over and over until the stack of papers is gone.



Figure 2. The processing station: a scanner, computer, and printer ready to turn drawings into take-home field maps.

Camera — photographing a single drawing

1. Hold the drawing flat under good light.
2. Tap the Camera button and allow the app to use the webcam.
3. The captured image is resized so its longest side is 1280 pixels, then filtered to red and blue.
4. With Auto-print enabled, the rest of the pipeline runs automatically.

Load — importing an already-made image

1. Tap Load and select a PNG or JPG from the computer.
2. The longest side is resized to 1280 pixels using nearest-neighbor sampling so that exact RGB values are preserved.
3. In Kids Mode the image is quantized to the basic red/blue colors. In General Mode the exact colors are kept.

Load is intended for expert users. Students in a booth should use Scan or Camera instead.

Draw — using the built-in magnet screen

1. Tap Draw to open the drawing screen.
2. Place virtual magnets by tapping the Z Magnet, X Magnet, or Y Magnet buttons and then tapping on the canvas.
3. Each charge is a colored disc. The app shows the live vector arrows and isolines as you work.
4. Tap Return to send only the colored discs back to the main screen for processing.
5. With Auto-print on, the returned drawing is processed and printed automatically.

1.6 Process, plot, and print

After a drawing is on the center screen, the green panel controls what happens next.

- Process — computes the magnetic field. This is the step that used to take minutes; now it is usually seconds.
- Plot ISO Lines — draws contour lines of equal field strength. Tight groups of lines mean a strong field.
- Plot Vectors — draws arrows showing the field direction at each point.
- Show ISO & Vectors — overlays both views for the most complete picture.
- Save — writes the finished image to a PNG file in your Pictures folder.
- Print — sends a white-background version to the printer.

1.7 What the printouts look like

The finished image is a square 1280×1280 plot. The app prints it on a white background so the printer does not waste toner. It is centered on the page and scaled to fit either A4 or Letter paper, whichever the printer uses. The green isolines repeat in a rainbow sequence so students can see which regions are strong and which are weak.



Figure 3. A typical student drawing: red and blue markers on white paper.

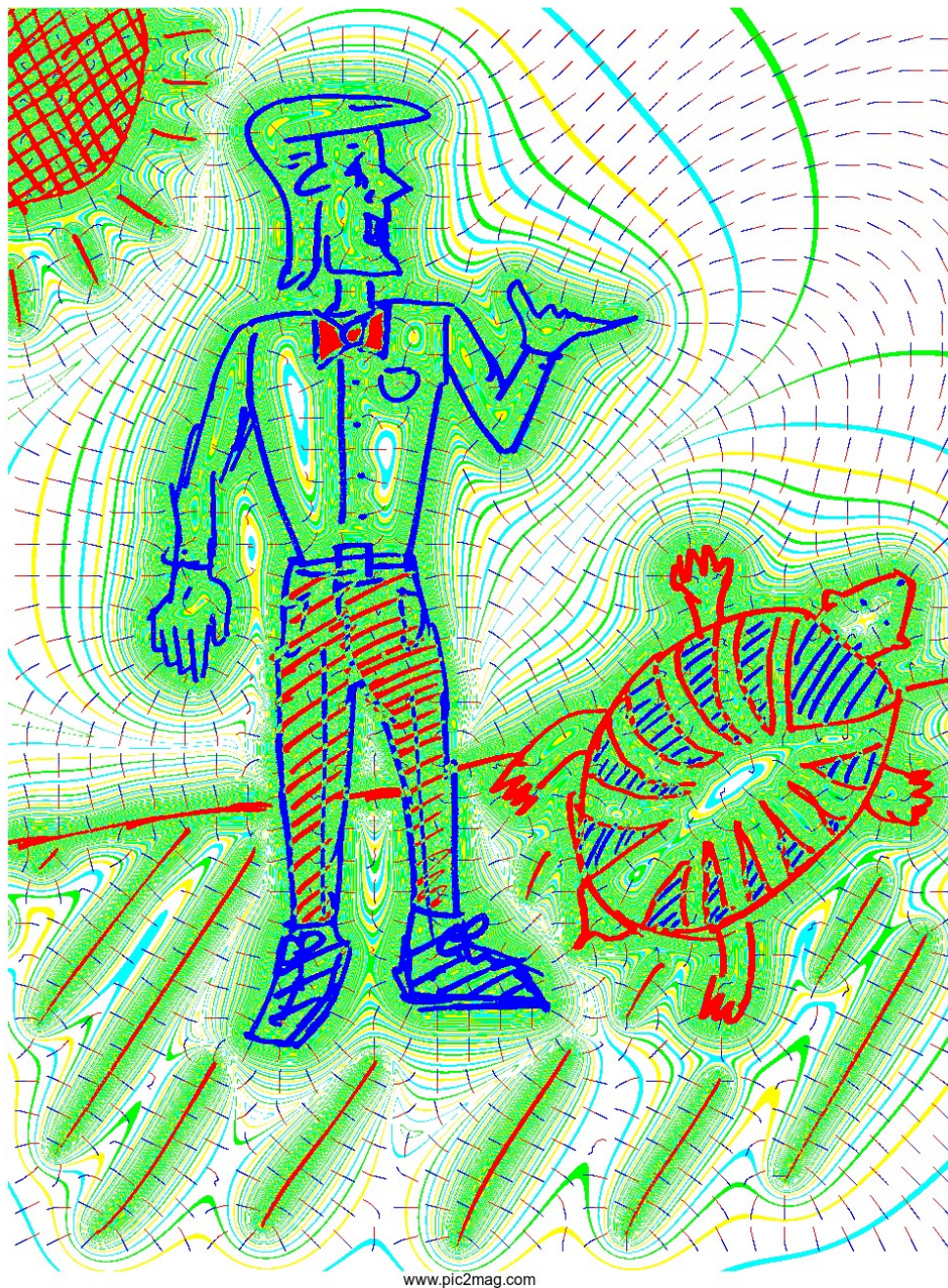


Figure 4. The same drawing after processing. The colored lines are isopotential contours; the tiny arrows are the vector field direction.

1.8 Gallery of student work

These are real drawings processed at public events. The students drew them with red and blue markers; the app added the field lines. Many students took the printouts home and hung them on the wall.

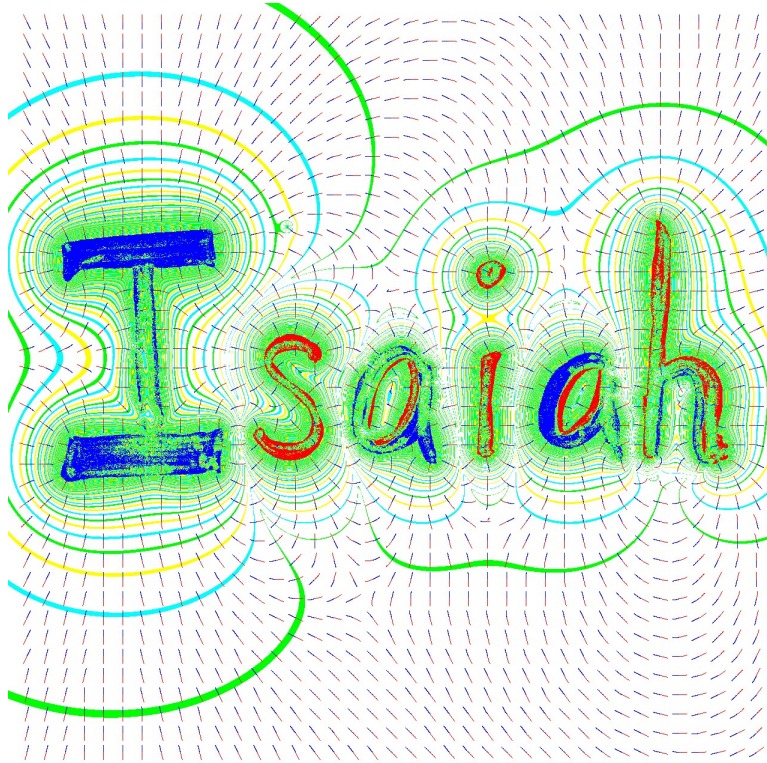


Figure 5. A student name-page processed with isopotential lines and vector arrows.

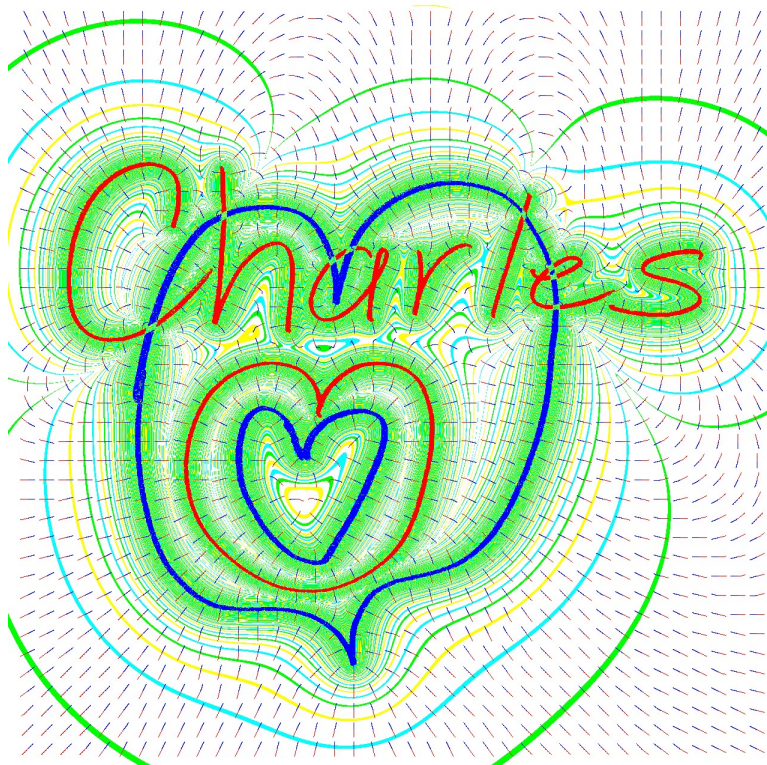


Figure 6. A heart-shaped message surrounded by the magnetic field it represents.

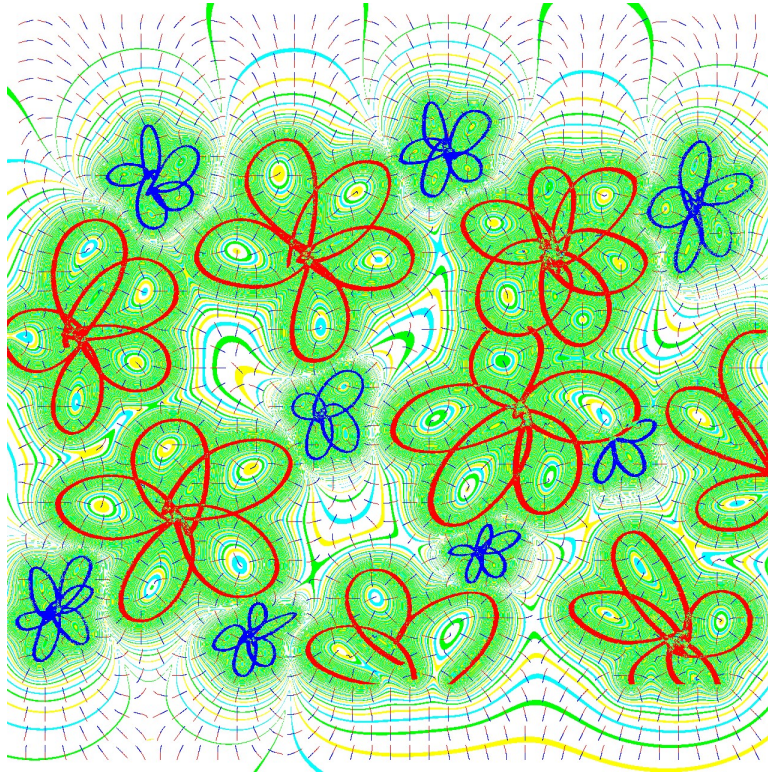


Figure 7. A field of flowers, where each red or blue flower becomes a magnet source.

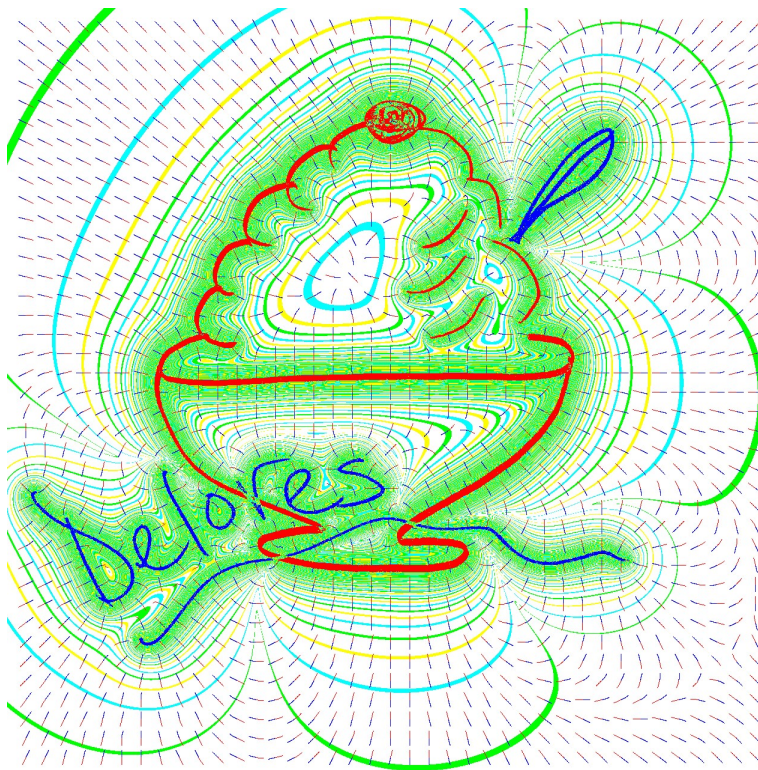


Figure 8. An abstract composition showing how even simple shapes create complex fields.



Figure 9. A slogan drawing — the letters themselves become the magnetic sources.



Figure 10. Finished pictures hung in the background while students come back to the booth to pick them up.

1.9 Auto-print mode

Auto-print is the secret to a smooth booth. When it is enabled and the app is in Kids Mode, the Scan, Camera, Load, and Draw buttons all feed the same automatic pipeline: acquire → quantize → process → plot → print. The first time you use Auto-print, the app asks for the printer. After that it remembers.

If Auto-print is turned off, the app returns to interactive mode: the teacher presses each green button by hand. Interactive mode is useful for demonstrating the steps to a class, while Auto-print is better for high-throughput booths.

1.10 Tips for a successful event

- Use dark red and dark blue markers. Pale or purple shades may be misread.
- Hatched lines work, but broad colors is more reliable.
- Keep the paper white. Colored paper confuses the color filter.
- If a drawing is upside down, rotate it before scanning; the app will not re-orient it.
- Always run a test print on the actual printer before the first students arrive.
- If the app shows blank, check that the drawing really has red and blue pixels and that Kids Mode is on.

1.11 Troubleshooting

No scanner found — Make sure the scanner is powered on and connected before starting the app. Windows must list it under Printers & Scanners.

No printer found — Install any printer driver and set it as default, or wait for the Auto-print picker to appear.

Colors look wrong after scanning — Increase the scanner resolution or use a darker marker. Avoid shadows when photographing.

Processed image is blank — The drawing may not contain any red or blue pixels. Check in an image viewer first.

2. Professional Drawings with Extended Colors

2.1 Why extended colors exist

The basic twelve colors are enough for most classroom drawings because they cover the main compass directions, the Z axis, and electric. But a real-world magnet is not made of eight discrete directions. A horseshoe magnet, for example, curves smoothly from one pole to the other. To represent that curve, Pic2Mag supports an extended palette of 360 colors, one for each degree of in-plane magnetic-moment angle.

The extended palette is the only place where the mapping from RGB value to angle is encoded. This means the colors are not just labels; they are also tied to screen position. Rotating an extended-color drawing breaks the encoding, because a color that meant 45° at one pixel is now at a different pixel where the magnet geometry expects a different angle.

2.2 The horseshoe magnet example

The horseshoe test image (Test Image 23 in the app) uses about 180 different extended colors to trace the bend of the magnet. Each color represents a one-degree step in the local magnetization direction along the horseshoe arms and curve. When processed, the result is an accurate field map of a classic horseshoe magnet.

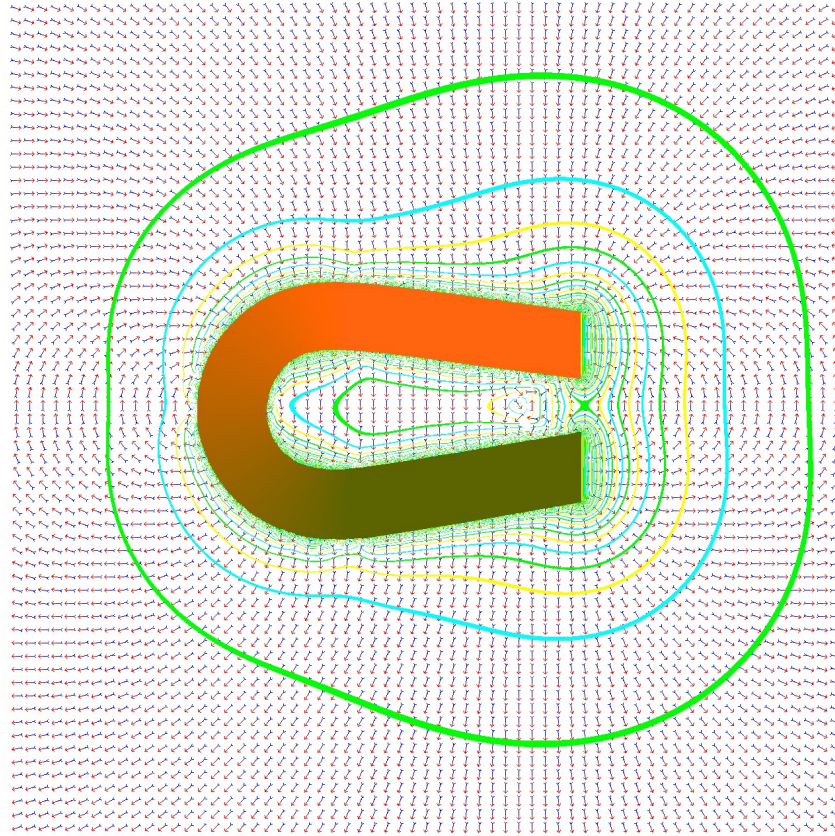


Figure 11. Processed horseshoe magnet on a white background. The isolines and vector arrows show the field between the poles.

2.3 Image Rotation breaks the encoding

Because the extended colors encode both angle and screen position, you cannot simply rotate a horseshoe source image and expect the same result. After rotation, the red-blue-green values move to new locations, but the program still interprets each RGB triple as the original angle. The magnet shape no longer matches the color-angle map, so the computed field is wrong.

The fix is to re-color the magnet after rotation. In an external editor, redraw the magnet using the correct angle at each new pixel. This is why the Load workflow is recommended for expert users who can create exact source images.

2.4 Creating precise drawings in an external editor

The original Field Calculator workflow recommended AutoCAD for the geometry and a simple paint program for the color. That advice still applies for the Science Fair app:

1. Draw the magnet layout in a CAD or vector program and export it at exactly 1280×1280 pixels.
2. Color each region with the exact RGB value from the color tables below. Use the Load button in General Mode.
3. The app resizes with nearest-neighbor sampling to preserve the exact RGB values.
4. Press Process, then Plot ISO Lines, Plot Vectors, or Show ISO & Vectors.

2.5 Base twelve colors

These are the colors recognized in Kids Mode and in the General Mode palette. White pixels (255, 255, 255) are empty space.

Angle / Role	Color name	RGB (R, G, B)
0° (12 o'clock up)	light yellow	255, 255, 128
45° (1:30 upper-right)	orange	255, 128, 0
90° (3 o'clock right)	aqua	0, 255, 255
135° (4:30 lower-right)	purple	128, 0, 255
180° (6 o'clock down)	dark green	0, 128, 64
225° (7:30 lower-left)	brown	128, 64, 0
270° (9 o'clock left)	green	0, 255, 0
315° (10:30 upper-left)	lavender	255, 128, 255
Z into page (South)	blue	0, 0, 255
Z out of page (North)	red	255, 0, 0
Electric Monopole source	pink	255, 0, 128
Electric Monopole sink	dark purple	128, 0, 128

2.6 Extended 360-degree color table

The following table gives the RGB value for each in-plane angle from 0° to 359°. All angles are measured clockwise from the 12 o'clock (up) direction.

0 to 89 deg	90 to 179 deg	180 to 269 deg	270 to 359 deg
0 deg (1,100, 1)	90 deg (91,100, 1)	180 deg (181,100, 1)	270 deg (255,100, 16)
1 deg (2,100, 1)	91 deg (92,100, 1)	181 deg (182,100, 1)	271 deg (255,100, 17)
2 deg (3,100, 1)	92 deg (93,100, 1)	182 deg (183,100, 1)	272 deg (255,100, 18)
3 deg (4,100, 1)	93 deg (94,100, 1)	183 deg (184,100, 1)	273 deg (255,100, 19)
4 deg (5,100, 1)	94 deg (95,100, 1)	184 deg (185,100, 1)	274 deg (255,100, 20)
5 deg (6,100, 1)	95 deg (96,100, 1)	185 deg (186,100, 1)	275 deg (255,100, 21)
6 deg (7,100, 1)	96 deg (97,100, 1)	186 deg (187,100, 1)	276 deg (255,100, 22)
7 deg (8,100, 1)	97 deg (98,100, 1)	187 deg (188,100, 1)	277 deg (255,100, 23)
8 deg (9,100, 1)	98 deg (99,100, 1)	188 deg (189,100, 1)	278 deg (255,100, 24)
9 deg (10,100, 1)	99 deg (100,100, 1)	189 deg (190,100, 1)	279 deg (255,100, 25)
10 deg (11,100, 1)	100 deg (101,100, 1)	190 deg (191,100, 1)	280 deg (255,100, 26)
11 deg (12,100, 1)	101 deg (102,100, 1)	191 deg (192,100, 1)	281 deg (255,100, 27)
12 deg (13,100, 1)	102 deg (103,100, 1)	192 deg (193,100, 1)	282 deg (255,100, 28)
13 deg (14,100, 1)	103 deg (104,100, 1)	193 deg (194,100, 1)	283 deg (255,100, 29)
14 deg (15,100, 1)	104 deg (105,100, 1)	194 deg (195,100, 1)	284 deg (255,100, 30)
15 deg (16,100, 1)	105 deg (106,100, 1)	195 deg (196,100, 1)	285 deg (255,100, 31)
16 deg (17,100, 1)	106 deg (107,100, 1)	196 deg (197,100, 1)	286 deg (255,100, 32)
17 deg (18,100, 1)	107 deg (108,100, 1)	197 deg (198,100, 1)	287 deg (255,100, 33)
18 deg (19,100, 1)	108 deg (109,100, 1)	198 deg (199,100, 1)	288 deg (255,100, 34)
19 deg (20,100, 1)	109 deg (110,100, 1)	199 deg (200,100, 1)	289 deg (255,100, 35)
20 deg (21,100, 1)	110 deg (111,100, 1)	200 deg (201,100, 1)	290 deg (255,100, 36)
21 deg (22,100, 1)	111 deg (112,100, 1)	201 deg (202,100, 1)	291 deg (255,100, 37)
22 deg (23,100, 1)	112 deg (113,100, 1)	202 deg (203,100, 1)	292 deg (255,100, 38)
23 deg (24,100, 1)	113 deg (114,100, 1)	203 deg (204,100, 1)	293 deg (255,100, 39)
24 deg (25,100, 1)	114 deg (115,100, 1)	204 deg (205,100, 1)	294 deg (255,100, 40)
25 deg (26,100, 1)	115 deg (116,100, 1)	205 deg (206,100, 1)	295 deg (255,100, 41)
26 deg (27,100, 1)	116 deg (117,100, 1)	206 deg (207,100, 1)	296 deg (255,100, 42)
27 deg (28,100, 1)	117 deg (118,100, 1)	207 deg (208,100, 1)	297 deg (255,100, 43)
28 deg (29,100, 1)	118 deg (119,100, 1)	208 deg (209,100, 1)	298 deg (255,100, 44)
29 deg (30,100, 1)	119 deg (120,100, 1)	209 deg (210,100, 1)	299 deg (255,100, 45)
30 deg (31,100, 1)	120 deg (121,100, 1)	210 deg (211,100, 1)	300 deg (255,100, 46)
31 deg (32,100, 1)	121 deg (122,100, 1)	211 deg (212,100, 1)	301 deg (255,100, 47)
32 deg (33,100, 1)	122 deg (123,100, 1)	212 deg (213,100, 1)	302 deg (255,100, 48)
33 deg (34,100, 1)	123 deg (124,100, 1)	213 deg (214,100, 1)	303 deg (255,100, 49)
34 deg (35,100, 1)	124 deg (125,100, 1)	214 deg (215,100, 1)	304 deg (255,100, 50)
35 deg (36,100, 1)	125 deg (126,100, 1)	215 deg (216,100, 1)	305 deg (255,100, 51)

36 deg (37,100, 1)	126 deg (127,100, 1)	216 deg (217,100, 1)	306 deg (255,100, 52)
37 deg (38,100, 1)	127 deg (128,100, 1)	217 deg (218,100, 1)	307 deg (255,100, 53)
38 deg (39,100, 1)	128 deg (129,100, 1)	218 deg (219,100, 1)	308 deg (255,100, 54)
39 deg (40,100, 1)	129 deg (130,100, 1)	219 deg (220,100, 1)	309 deg (255,100, 55)
40 deg (41,100, 1)	130 deg (131,100, 1)	220 deg (221,100, 1)	310 deg (255,100, 56)
41 deg (42,100, 1)	131 deg (132,100, 1)	221 deg (222,100, 1)	311 deg (255,100, 57)
42 deg (43,100, 1)	132 deg (133,100, 1)	222 deg (223,100, 1)	312 deg (255,100, 58)
43 deg (44,100, 1)	133 deg (134,100, 1)	223 deg (224,100, 1)	313 deg (255,100, 59)
44 deg (45,100, 1)	134 deg (135,100, 1)	224 deg (225,100, 1)	314 deg (255,100, 60)
45 deg (46,100, 1)	135 deg (136,100, 1)	225 deg (226,100, 1)	315 deg (255,100, 61)
46 deg (47,100, 1)	136 deg (137,100, 1)	226 deg (227,100, 1)	316 deg (255,100, 62)
47 deg (48,100, 1)	137 deg (138,100, 1)	227 deg (228,100, 1)	317 deg (255,100, 63)
48 deg (49,100, 1)	138 deg (139,100, 1)	228 deg (229,100, 1)	318 deg (255,100, 64)
49 deg (50,100, 1)	139 deg (140,100, 1)	229 deg (230,100, 1)	319 deg (255,100, 65)
50 deg (51,100, 1)	140 deg (141,100, 1)	230 deg (231,100, 1)	320 deg (255,100, 66)
51 deg (52,100, 1)	141 deg (142,100, 1)	231 deg (232,100, 1)	321 deg (255,100, 67)
52 deg (53,100, 1)	142 deg (143,100, 1)	232 deg (233,100, 1)	322 deg (255,100, 68)
53 deg (54,100, 1)	143 deg (144,100, 1)	233 deg (234,100, 1)	323 deg (255,100, 69)
54 deg (55,100, 1)	144 deg (145,100, 1)	234 deg (235,100, 1)	324 deg (255,100, 70)
55 deg (56,100, 1)	145 deg (146,100, 1)	235 deg (236,100, 1)	325 deg (255,100, 71)
56 deg (57,100, 1)	146 deg (147,100, 1)	236 deg (237,100, 1)	326 deg (255,100, 72)
57 deg (58,100, 1)	147 deg (148,100, 1)	237 deg (238,100, 1)	327 deg (255,100, 73)
58 deg (59,100, 1)	148 deg (149,100, 1)	238 deg (239,100, 1)	328 deg (255,100, 74)
59 deg (60,100, 1)	149 deg (150,100, 1)	239 deg (240,100, 1)	329 deg (255,100, 75)
60 deg (61,100, 1)	150 deg (151,100, 1)	240 deg (241,100, 1)	330 deg (255,100, 76)
61 deg (62,100, 1)	151 deg (152,100, 1)	241 deg (242,100, 1)	331 deg (255,100, 77)
62 deg (63,100, 1)	152 deg (153,100, 1)	242 deg (243,100, 1)	332 deg (255,100, 78)
63 deg (64,100, 1)	153 deg (154,100, 1)	243 deg (244,100, 1)	333 deg (255,100, 79)
64 deg (65,100, 1)	154 deg (155,100, 1)	244 deg (245,100, 1)	334 deg (255,100, 80)
65 deg (66,100, 1)	155 deg (156,100, 1)	245 deg (246,100, 1)	335 deg (255,100, 81)
66 deg (67,100, 1)	156 deg (157,100, 1)	246 deg (247,100, 1)	336 deg (255,100, 82)
67 deg (68,100, 1)	157 deg (158,100, 1)	247 deg (248,100, 1)	337 deg (255,100, 83)
68 deg (69,100, 1)	158 deg (159,100, 1)	248 deg (249,100, 1)	338 deg (255,100, 84)
69 deg (70,100, 1)	159 deg (160,100, 1)	249 deg (250,100, 1)	339 deg (255,100, 85)
70 deg (71,100, 1)	160 deg (161,100, 1)	250 deg (251,100, 1)	340 deg (255,100, 86)
71 deg (72,100, 1)	161 deg (162,100, 1)	251 deg (252,100, 1)	341 deg (255,100, 87)
72 deg (73,100, 1)	162 deg (163,100, 1)	252 deg (253,100, 1)	342 deg (255,100, 88)
73 deg (74,100, 1)	163 deg (164,100, 1)	253 deg (254,100, 1)	343 deg (255,100, 89)
74 deg (75,100, 1)	164 deg (165,100, 1)	254 deg (255,100, 1)	344 deg (255,100, 90)
75 deg (76,100, 1)	165 deg (166,100, 1)	255 deg (255,100, 1)	345 deg (255,100, 91)
76 deg (77,100, 1)	166 deg (167,100, 1)	256 deg (255,100, 2)	346 deg (255,100, 92)
77 deg (78,100, 1)	167 deg (168,100, 1)	257 deg (255,100, 3)	347 deg (255,100, 93)
78 deg (79,100, 1)	168 deg (169,100, 1)	258 deg (255,100, 4)	348 deg (255,100, 94)
79 deg (80,100, 1)	169 deg (170,100, 1)	259 deg (255,100, 5)	349 deg (255,100, 95)
80 deg (81,100, 1)	170 deg (171,100, 1)	260 deg (255,100, 6)	350 deg (255,100, 96)
81 deg (82,100, 1)	171 deg (172,100, 1)	261 deg (255,100, 7)	351 deg (255,100, 97)
82 deg (83,100, 1)	172 deg (173,100, 1)	262 deg (255,100, 8)	352 deg (255,100, 98)
83 deg (84,100, 1)	173 deg (174,100, 1)	263 deg (255,100, 9)	353 deg (255,100, 99)
84 deg (85,100, 1)	174 deg (175,100, 1)	264 deg (255,100, 10)	354 deg (255,100,100)
85 deg (86,100, 1)	175 deg (176,100, 1)	265 deg (255,100, 11)	355 deg (255,100,101)
86 deg (87,100, 1)	176 deg (177,100, 1)	266 deg (255,100, 12)	356 deg (255,100,102)
87 deg (88,100, 1)	177 deg (178,100, 1)	267 deg (255,100, 13)	357 deg (255,100,103)
88 deg (89,100, 1)	178 deg (179,100, 1)	268 deg (255,100, 14)	358 deg (255,100,104)
89 deg (90,100, 1)	179 deg (180,100, 1)	269 deg (255,100, 15)	359 deg (255,100,105)

3. The Ferrocell Easter Egg

3.1 What is a ferrocell?

A ferrocell is a thin layer of ferrofluid sandwiched between two pieces of glass. When a magnet is placed underneath, the tiny magnetic nanoparticles in the fluid arrange themselves into chain-like structures along the local magnetic field. Light shining through the cell is scattered and reflected differently depending on the orientation of these chains, so the cell acts as a visible window into the invisible field. The effect is both beautiful and scientifically accurate.

3.2 How to access the mode

The Science Fair app includes a ferrocell renderer. To turn it on, press the Plot ISO button for about three/four seconds after processing in the normal interactive mode with Auto-Print mode turned off. The center image switches to a dark, iridescent ferrocell-style view.

3.3 What you see

The ferrocell view uses the live B-field computed from the current drawing. It renders the field as if it were a thin film of ferrofluid illuminated by colored lights placed around the edge. Bright streaks and colored fringes appear where the field lines would be dense; dark regions appear where the field is weak or absent.

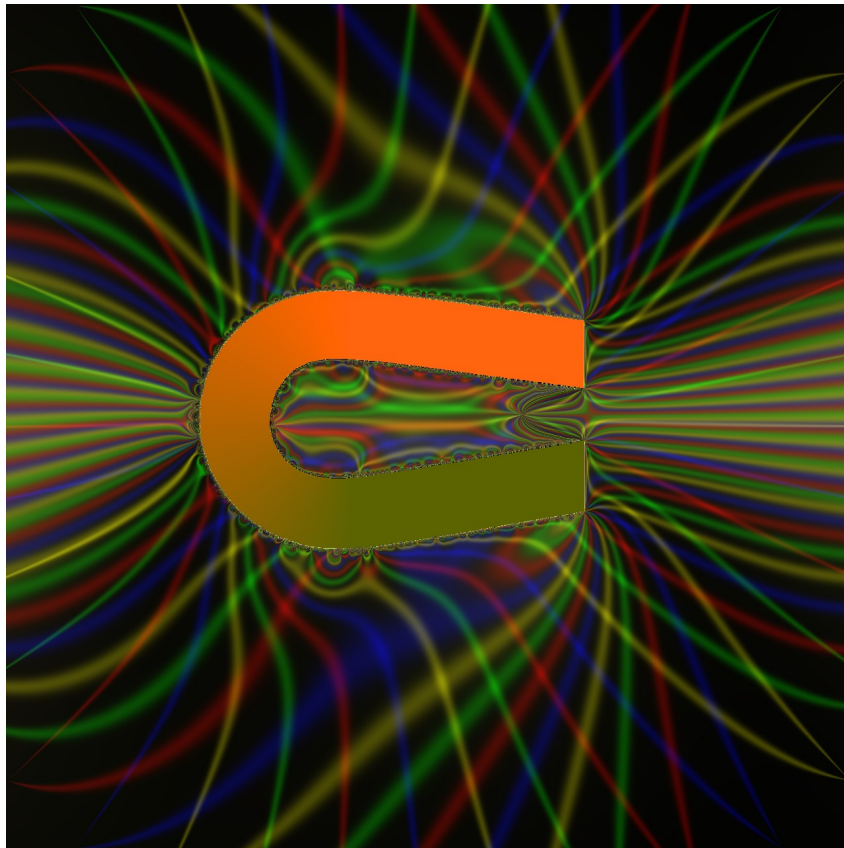


Figure 12. Ferrocell-mode rendering of the horseshoe magnet. The colored filaments trace the reflection of the magnetic field.

3.4 The math behind the view

The renderer is based on Lori Gardi's dual-channel lighting model. The app first normalizes the computed B-field at every pixel to get a unit direction vector μ . A set of colored light sources is arranged in a circle around the image. For each light, the algorithm computes the surface normal N that would reflect that light toward the observer. The contribution of the light is brightest where μ aligns closely with N , using a Gaussian weighting $\exp(-(\mu \cdot N)^2 / 2\sigma^2)$. Contributions from all lights are accumulated into the final RGB image.

An optional scattering channel adds a second lighting model that mimics the way light diffuses through the nanoparticle chains. The result is not a photograph of a real ferrocell, but a computed image that reproduces similar visual features: bright lines where the field is strong and tangled, and dark quiet zones where the field is weak or uniform.

3.5 Credits

Ferrocell lighting model: Lori Gardi.

Ferrocell research and the book *Ferrocell and Magnetic Patterns*: Alberto Tufaile and Adriana Pedrosa Biscaia Tufaile, Soft Matter Laboratory, EACH-USP.

Pic2Mag Science Fair app and GPU field solver: Michael Snyder (Pic2Mag).

3.6 Printing the ferrocell view

The ferrocell view is best used on screen/projection for demonstrations. Because it is a dark image, printing it would consume a lot of toner.

Appendix A. Combined Color Reference

This appendix repeats the base twelve colors and the full 360-degree extended table in one place for quick lookup.

Angle / Role	Color name	RGB (R, G, B)
0° (12 o'clock up)	light yellow	255, 255, 128
45° (1:30 upper-right)	orange	255, 128, 0
90° (3 o'clock right)	aqua	0, 255, 255
135° (4:30 lower-right)	purple	128, 0, 255
180° (6 o'clock down)	dark green	0, 128, 64
225° (7:30 lower-left)	brown	128, 64, 0
270° (9 o'clock left)	green	0, 255, 0
315° (10:30 upper-left)	lavender	255, 128, 255
Z into page (South)	blue	0, 0, 255
Z out of page (North)	red	255, 0, 0
Monopole source	pink	255, 0, 128
Monopole sink	dark purple	128, 0, 128

Extended colors (0°–359°). The format is angle followed by (R,G,B).

0 to 89 deg	90 to 179 deg	180 to 269 deg	270 to 359 deg
0 deg (1,100, 1)	90 deg (91,100, 1)	180 deg (181,100, 1)	270 deg (255,100, 16)
1 deg (2,100, 1)	91 deg (92,100, 1)	181 deg (182,100, 1)	271 deg (255,100, 17)
2 deg (3,100, 1)	92 deg (93,100, 1)	182 deg (183,100, 1)	272 deg (255,100, 18)
3 deg (4,100, 1)	93 deg (94,100, 1)	183 deg (184,100, 1)	273 deg (255,100, 19)
4 deg (5,100, 1)	94 deg (95,100, 1)	184 deg (185,100, 1)	274 deg (255,100, 20)
5 deg (6,100, 1)	95 deg (96,100, 1)	185 deg (186,100, 1)	275 deg (255,100, 21)
6 deg (7,100, 1)	96 deg (97,100, 1)	186 deg (187,100, 1)	276 deg (255,100, 22)
7 deg (8,100, 1)	97 deg (98,100, 1)	187 deg (188,100, 1)	277 deg (255,100, 23)
8 deg (9,100, 1)	98 deg (99,100, 1)	188 deg (189,100, 1)	278 deg (255,100, 24)
9 deg (10,100, 1)	99 deg (100,100, 1)	189 deg (190,100, 1)	279 deg (255,100, 25)
10 deg (11,100, 1)	100 deg (101,100, 1)	190 deg (191,100, 1)	280 deg (255,100, 26)
11 deg (12,100, 1)	101 deg (102,100, 1)	191 deg (192,100, 1)	281 deg (255,100, 27)
12 deg (13,100, 1)	102 deg (103,100, 1)	192 deg (193,100, 1)	282 deg (255,100, 28)
13 deg (14,100, 1)	103 deg (104,100, 1)	193 deg (194,100, 1)	283 deg (255,100, 29)
14 deg (15,100, 1)	104 deg (105,100, 1)	194 deg (195,100, 1)	284 deg (255,100, 30)
15 deg (16,100, 1)	105 deg (106,100, 1)	195 deg (196,100, 1)	285 deg (255,100, 31)
16 deg (17,100, 1)	106 deg (107,100, 1)	196 deg (197,100, 1)	286 deg (255,100, 32)
17 deg (18,100, 1)	107 deg (108,100, 1)	197 deg (198,100, 1)	287 deg (255,100, 33)
18 deg (19,100, 1)	108 deg (109,100, 1)	198 deg (199,100, 1)	288 deg (255,100, 34)
19 deg (20,100, 1)	109 deg (110,100, 1)	199 deg (200,100, 1)	289 deg (255,100, 35)
20 deg (21,100, 1)	110 deg (111,100, 1)	200 deg (201,100, 1)	290 deg (255,100, 36)
21 deg (22,100, 1)	111 deg (112,100, 1)	201 deg (202,100, 1)	291 deg (255,100, 37)
22 deg (23,100, 1)	112 deg (113,100, 1)	202 deg (203,100, 1)	292 deg (255,100, 38)
23 deg (24,100, 1)	113 deg (114,100, 1)	203 deg (204,100, 1)	293 deg (255,100, 39)
24 deg (25,100, 1)	114 deg (115,100, 1)	204 deg (205,100, 1)	294 deg (255,100, 40)
25 deg (26,100, 1)	115 deg (116,100, 1)	205 deg (206,100, 1)	295 deg (255,100, 41)
26 deg (27,100, 1)	116 deg (117,100, 1)	206 deg (207,100, 1)	296 deg (255,100, 42)
27 deg (28,100, 1)	117 deg (118,100, 1)	207 deg (208,100, 1)	297 deg (255,100, 43)
28 deg (29,100, 1)	118 deg (119,100, 1)	208 deg (209,100, 1)	298 deg (255,100, 44)
29 deg (30,100, 1)	119 deg (120,100, 1)	209 deg (210,100, 1)	299 deg (255,100, 45)
30 deg (31,100, 1)	120 deg (121,100, 1)	210 deg (211,100, 1)	300 deg (255,100, 46)
31 deg (32,100, 1)	121 deg (122,100, 1)	211 deg (212,100, 1)	301 deg (255,100, 47)
32 deg (33,100, 1)	122 deg (123,100, 1)	212 deg (213,100, 1)	302 deg (255,100, 48)
33 deg (34,100, 1)	123 deg (124,100, 1)	213 deg (214,100, 1)	303 deg (255,100, 49)
34 deg (35,100, 1)	124 deg (125,100, 1)	214 deg (215,100, 1)	304 deg (255,100, 50)
35 deg (36,100, 1)	125 deg (126,100, 1)	215 deg (216,100, 1)	305 deg (255,100, 51)
36 deg (37,100, 1)	126 deg (127,100, 1)	216 deg (217,100, 1)	306 deg (255,100, 52)
37 deg (38,100, 1)	127 deg (128,100, 1)	217 deg (218,100, 1)	307 deg (255,100, 53)
38 deg (39,100, 1)	128 deg (129,100, 1)	218 deg (219,100, 1)	308 deg (255,100, 54)
39 deg (40,100, 1)	129 deg (130,100, 1)	219 deg (220,100, 1)	309 deg (255,100, 55)
40 deg (41,100, 1)	130 deg (131,100, 1)	220 deg (221,100, 1)	310 deg (255,100, 56)
41 deg (42,100, 1)	131 deg (132,100, 1)	221 deg (222,100, 1)	311 deg (255,100, 57)

42 deg (43,100, 1)	132 deg (133,100, 1)	222 deg (223,100, 1)	312 deg (255,100, 58)
43 deg (44,100, 1)	133 deg (134,100, 1)	223 deg (224,100, 1)	313 deg (255,100, 59)
44 deg (45,100, 1)	134 deg (135,100, 1)	224 deg (225,100, 1)	314 deg (255,100, 60)
45 deg (46,100, 1)	135 deg (136,100, 1)	225 deg (226,100, 1)	315 deg (255,100, 61)
46 deg (47,100, 1)	136 deg (137,100, 1)	226 deg (227,100, 1)	316 deg (255,100, 62)
47 deg (48,100, 1)	137 deg (138,100, 1)	227 deg (228,100, 1)	317 deg (255,100, 63)
48 deg (49,100, 1)	138 deg (139,100, 1)	228 deg (229,100, 1)	318 deg (255,100, 64)
49 deg (50,100, 1)	139 deg (140,100, 1)	229 deg (230,100, 1)	319 deg (255,100, 65)
50 deg (51,100, 1)	140 deg (141,100, 1)	230 deg (231,100, 1)	320 deg (255,100, 66)
51 deg (52,100, 1)	141 deg (142,100, 1)	231 deg (232,100, 1)	321 deg (255,100, 67)
52 deg (53,100, 1)	142 deg (143,100, 1)	232 deg (233,100, 1)	322 deg (255,100, 68)
53 deg (54,100, 1)	143 deg (144,100, 1)	233 deg (234,100, 1)	323 deg (255,100, 69)
54 deg (55,100, 1)	144 deg (145,100, 1)	234 deg (235,100, 1)	324 deg (255,100, 70)
55 deg (56,100, 1)	145 deg (146,100, 1)	235 deg (236,100, 1)	325 deg (255,100, 71)
56 deg (57,100, 1)	146 deg (147,100, 1)	236 deg (237,100, 1)	326 deg (255,100, 72)
57 deg (58,100, 1)	147 deg (148,100, 1)	237 deg (238,100, 1)	327 deg (255,100, 73)
58 deg (59,100, 1)	148 deg (149,100, 1)	238 deg (239,100, 1)	328 deg (255,100, 74)
59 deg (60,100, 1)	149 deg (150,100, 1)	239 deg (240,100, 1)	329 deg (255,100, 75)
60 deg (61,100, 1)	150 deg (151,100, 1)	240 deg (241,100, 1)	330 deg (255,100, 76)
61 deg (62,100, 1)	151 deg (152,100, 1)	241 deg (242,100, 1)	331 deg (255,100, 77)
62 deg (63,100, 1)	152 deg (153,100, 1)	242 deg (243,100, 1)	332 deg (255,100, 78)
63 deg (64,100, 1)	153 deg (154,100, 1)	243 deg (244,100, 1)	333 deg (255,100, 79)
64 deg (65,100, 1)	154 deg (155,100, 1)	244 deg (245,100, 1)	334 deg (255,100, 80)
65 deg (66,100, 1)	155 deg (156,100, 1)	245 deg (246,100, 1)	335 deg (255,100, 81)
66 deg (67,100, 1)	156 deg (157,100, 1)	246 deg (247,100, 1)	336 deg (255,100, 82)
67 deg (68,100, 1)	157 deg (158,100, 1)	247 deg (248,100, 1)	337 deg (255,100, 83)
68 deg (69,100, 1)	158 deg (159,100, 1)	248 deg (249,100, 1)	338 deg (255,100, 84)
69 deg (70,100, 1)	159 deg (160,100, 1)	249 deg (250,100, 1)	339 deg (255,100, 85)
70 deg (71,100, 1)	160 deg (161,100, 1)	250 deg (251,100, 1)	340 deg (255,100, 86)
71 deg (72,100, 1)	161 deg (162,100, 1)	251 deg (252,100, 1)	341 deg (255,100, 87)
72 deg (73,100, 1)	162 deg (163,100, 1)	252 deg (253,100, 1)	342 deg (255,100, 88)
73 deg (74,100, 1)	163 deg (164,100, 1)	253 deg (254,100, 1)	343 deg (255,100, 89)
74 deg (75,100, 1)	164 deg (165,100, 1)	254 deg (255,100, 1)	344 deg (255,100, 90)
75 deg (76,100, 1)	165 deg (166,100, 1)	255 deg (255,100, 1)	345 deg (255,100, 91)
76 deg (77,100, 1)	166 deg (167,100, 1)	256 deg (255,100, 2)	346 deg (255,100, 92)
77 deg (78,100, 1)	167 deg (168,100, 1)	257 deg (255,100, 3)	347 deg (255,100, 93)
78 deg (79,100, 1)	168 deg (169,100, 1)	258 deg (255,100, 4)	348 deg (255,100, 94)
79 deg (80,100, 1)	169 deg (170,100, 1)	259 deg (255,100, 5)	349 deg (255,100, 95)
80 deg (81,100, 1)	170 deg (171,100, 1)	260 deg (255,100, 6)	350 deg (255,100, 96)
81 deg (82,100, 1)	171 deg (172,100, 1)	261 deg (255,100, 7)	351 deg (255,100, 97)
82 deg (83,100, 1)	172 deg (173,100, 1)	262 deg (255,100, 8)	352 deg (255,100, 98)
83 deg (84,100, 1)	173 deg (174,100, 1)	263 deg (255,100, 9)	353 deg (255,100, 99)
84 deg (85,100, 1)	174 deg (175,100, 1)	264 deg (255,100, 10)	354 deg (255,100,100)
85 deg (86,100, 1)	175 deg (176,100, 1)	265 deg (255,100, 11)	355 deg (255,100,101)
86 deg (87,100, 1)	176 deg (177,100, 1)	266 deg (255,100, 12)	356 deg (255,100,102)
87 deg (88,100, 1)	177 deg (178,100, 1)	267 deg (255,100, 13)	357 deg (255,100,103)
88 deg (89,100, 1)	178 deg (179,100, 1)	268 deg (255,100, 14)	358 deg (255,100,104)
89 deg (90,100, 1)	179 deg (180,100, 1)	269 deg (255,100, 15)	359 deg (255,100,105)