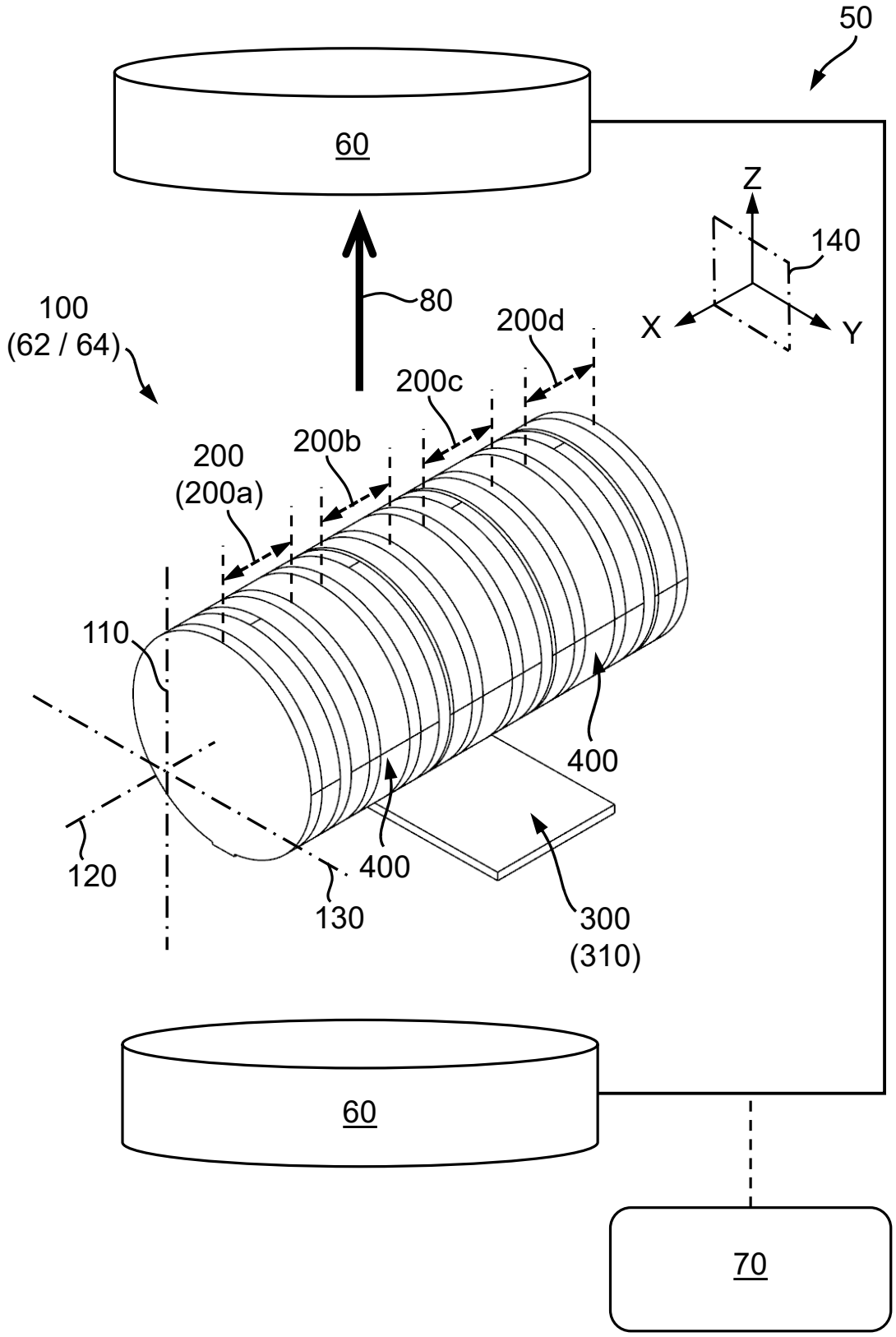

50
60
Z
140
X
Y
80
100
(62 / 64)
200d
200c
200b
200
(200a)
110
400
120
400
130
300
(310)
60
70

FIG. 1

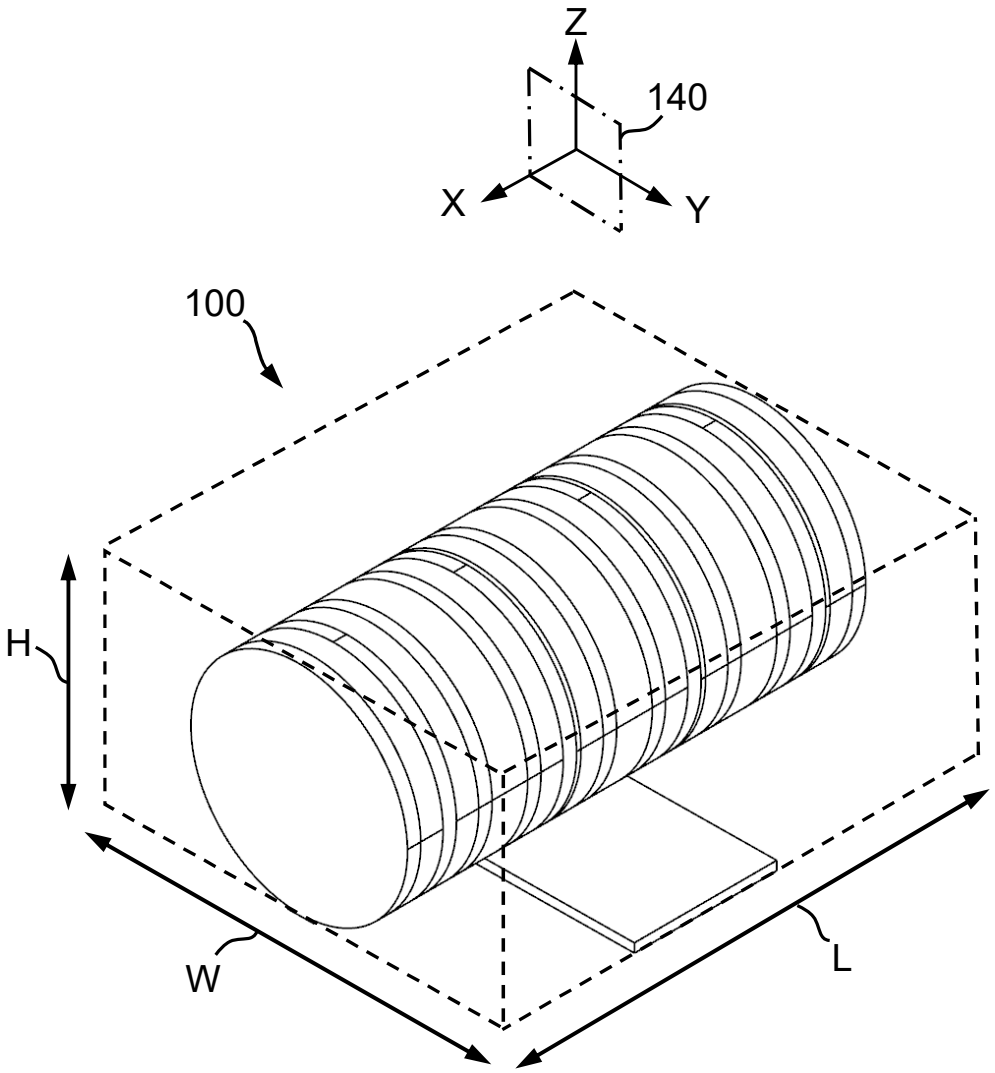


FIG. 2

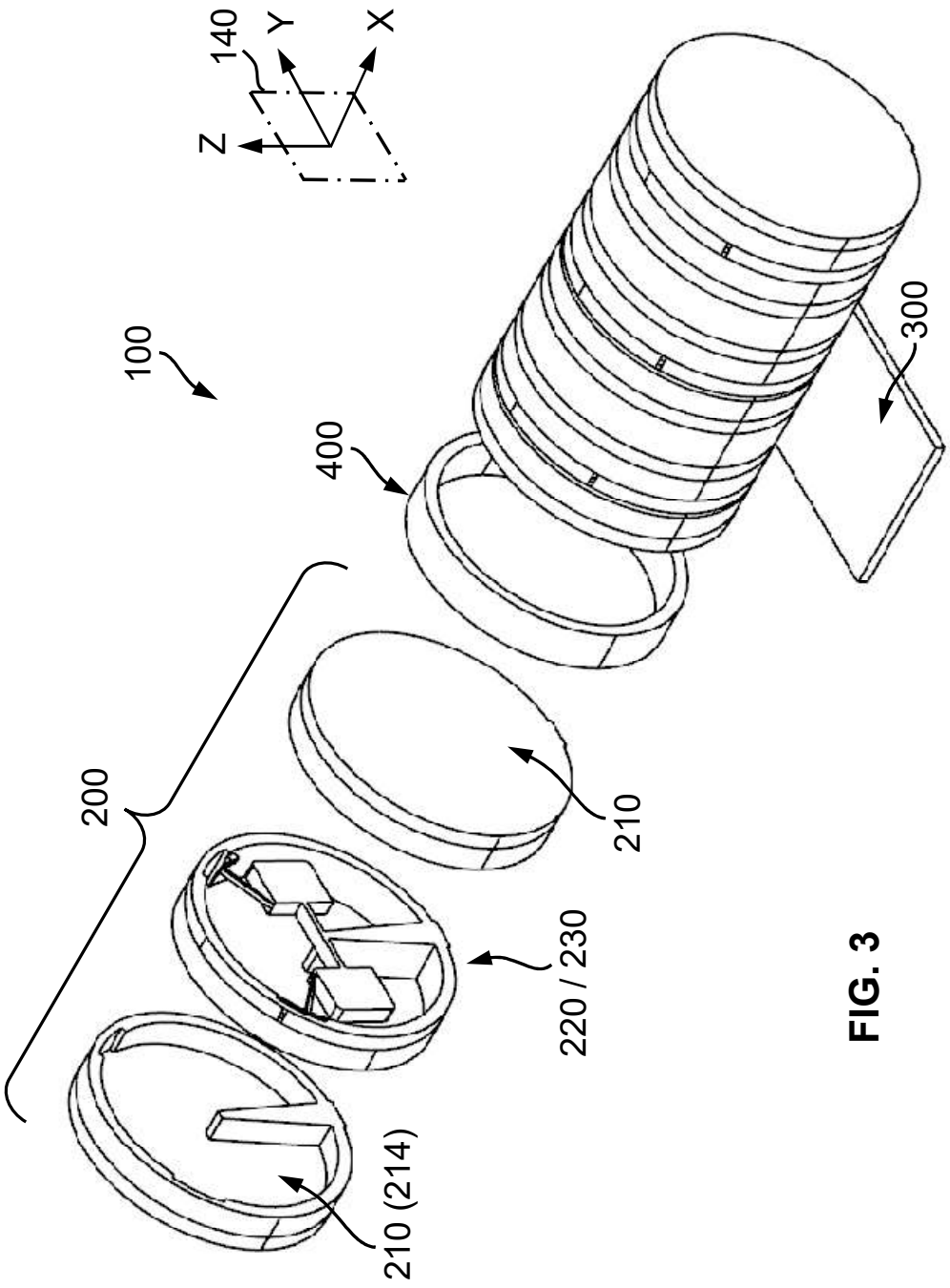


FIG. 3

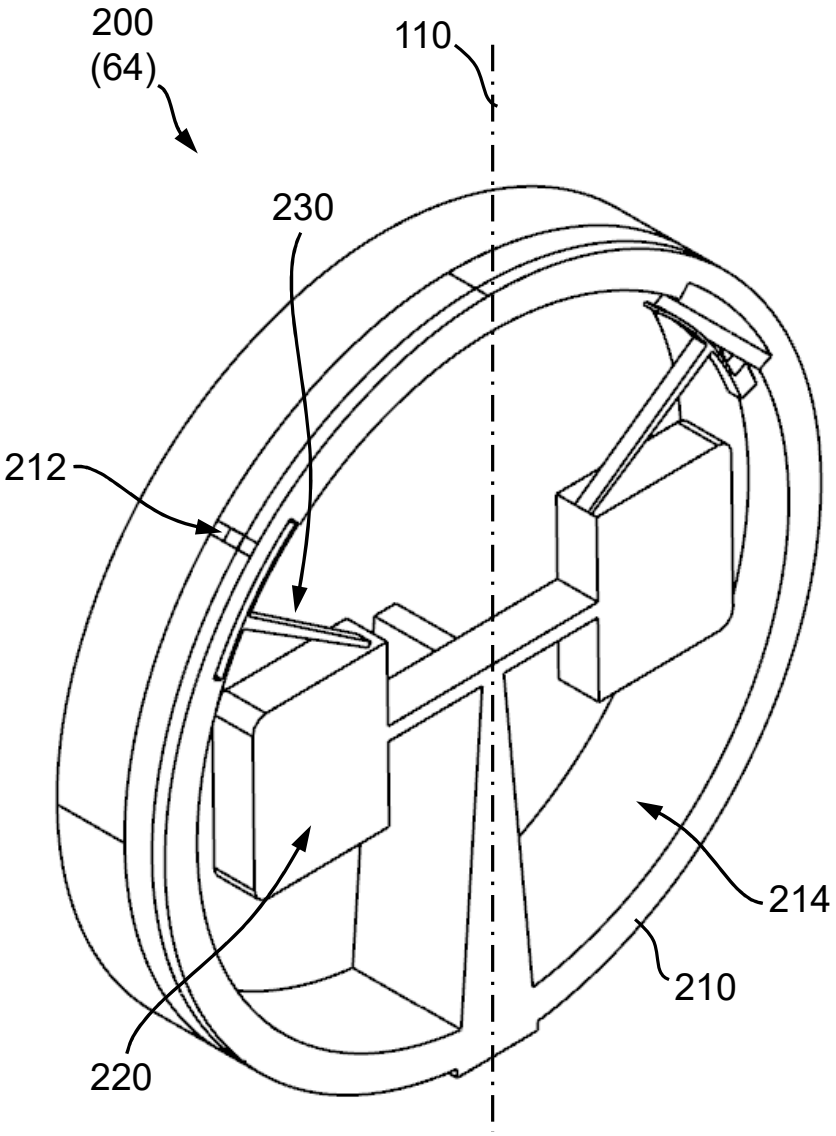


FIG. 4

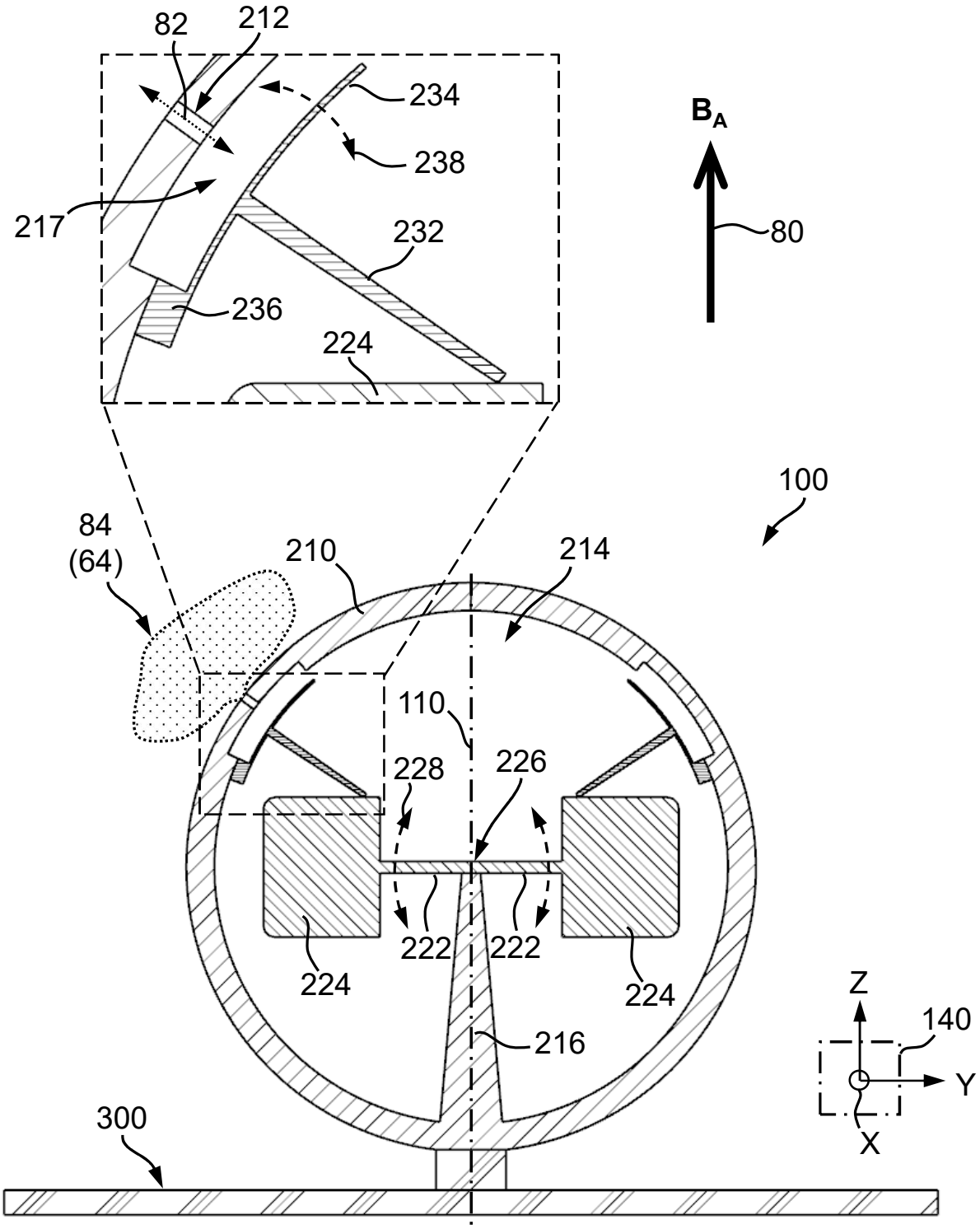

82
212
234
238
217
232
236
224
B_A
80
100
84
(64)
210
214
110
228
226
222
222
224
224
216
300
Z
140
Y
X

FIG. 5

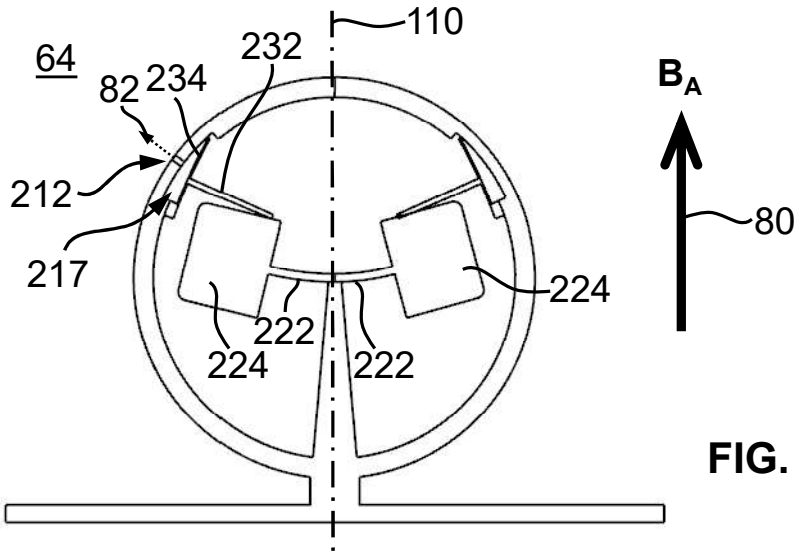


FIG. 6A

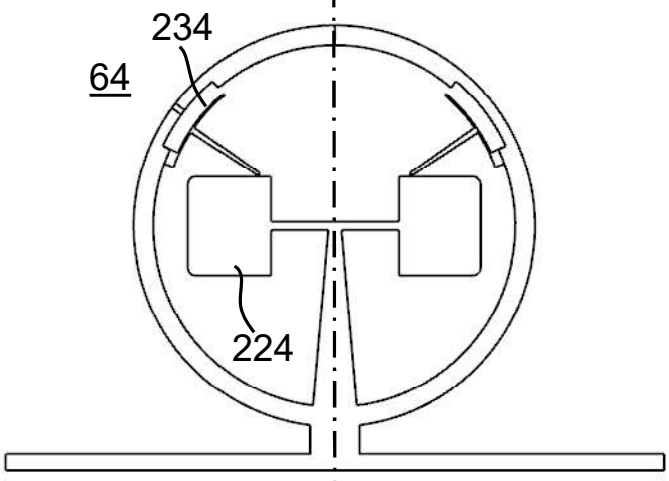


FIG. 6B

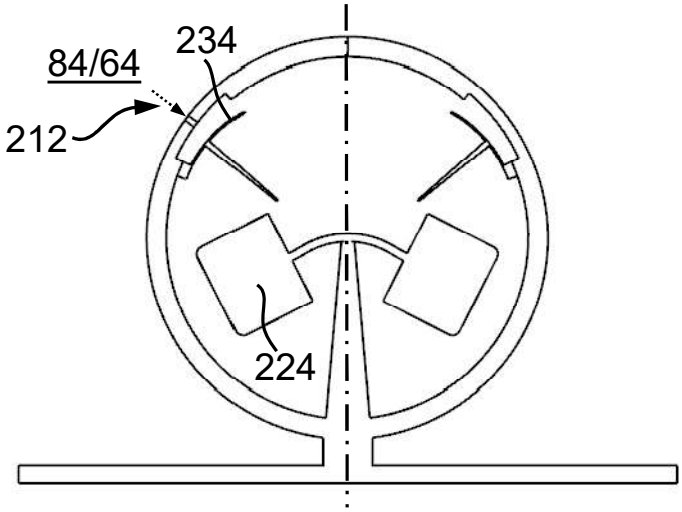


FIG. 6C

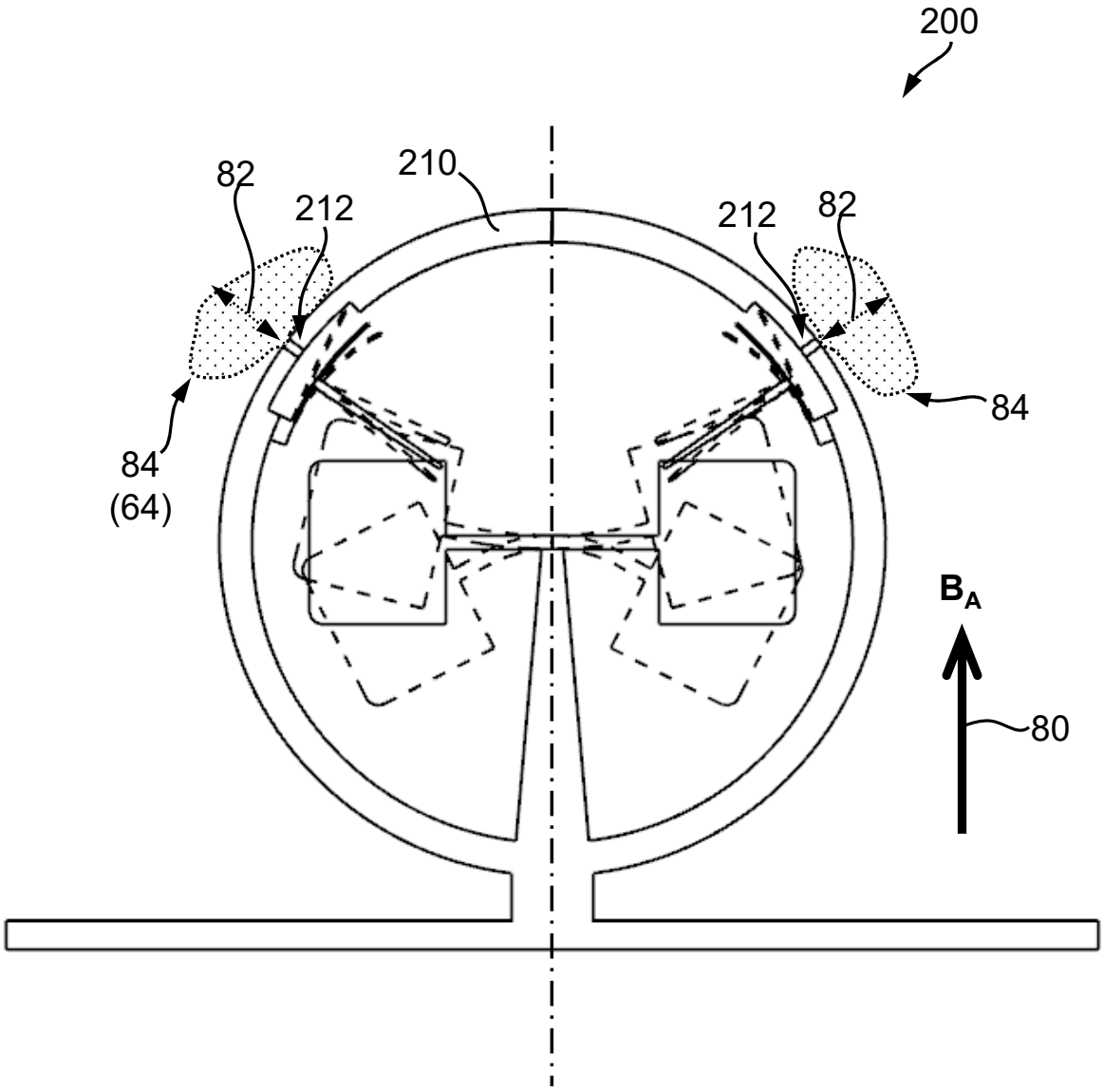


FIG. 7

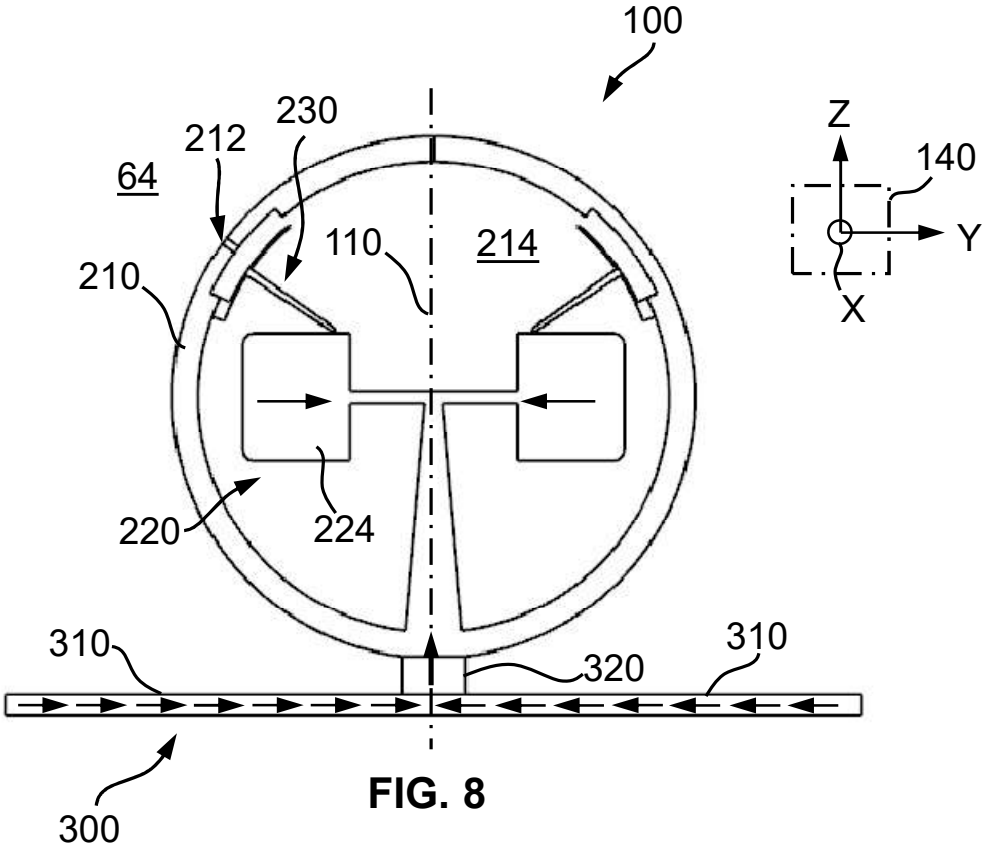

100
230
212
64
110
214
210
220
224
Z
140
Y
X
310
320
310
300

FIG. 8

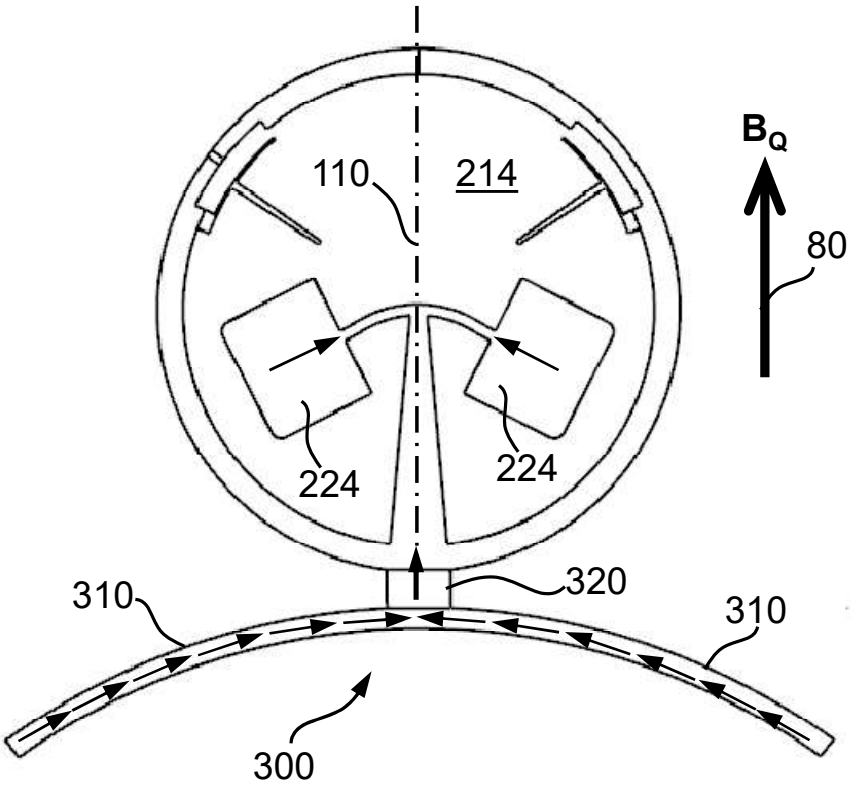

110
214
B_Q
80
224
224
310
320
310
300

FIG. 9

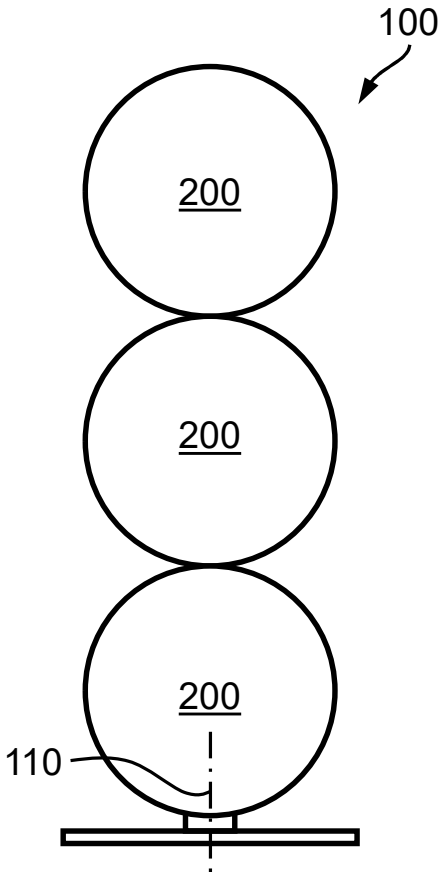


FIG. 10A

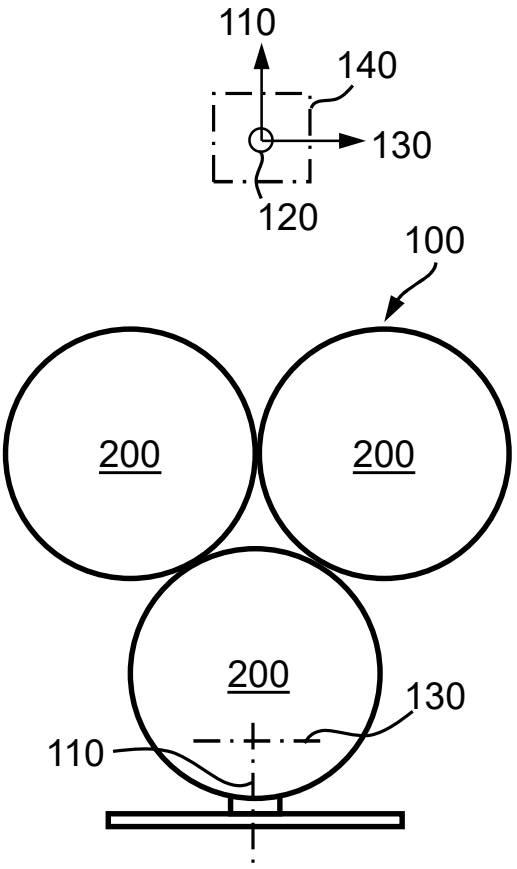


FIG. 10B

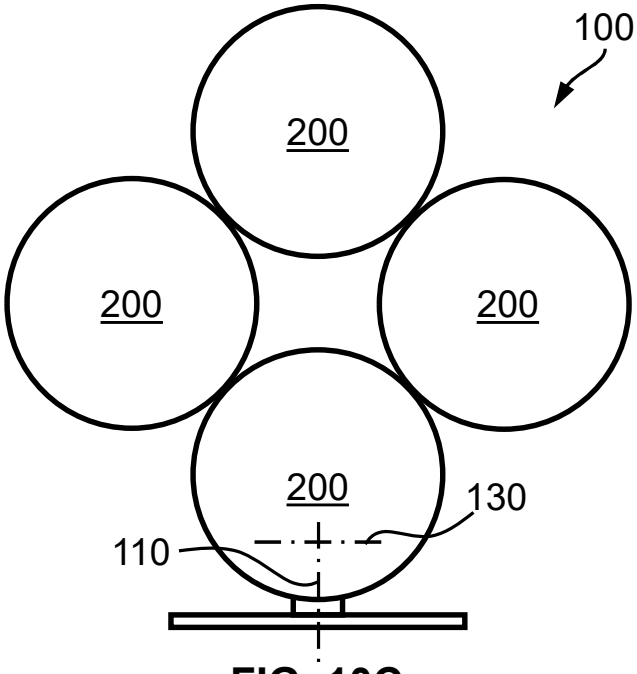


FIG. 10C

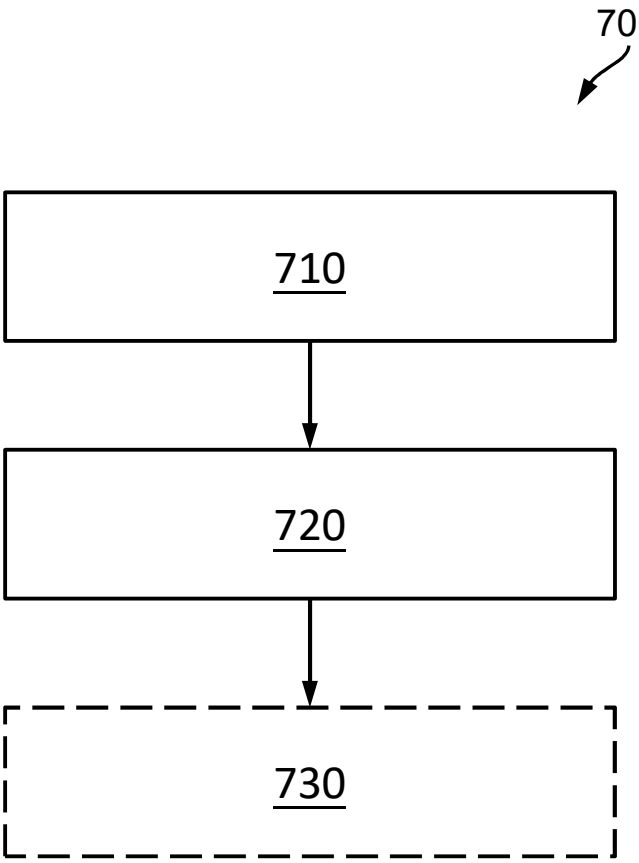


FIG. 11

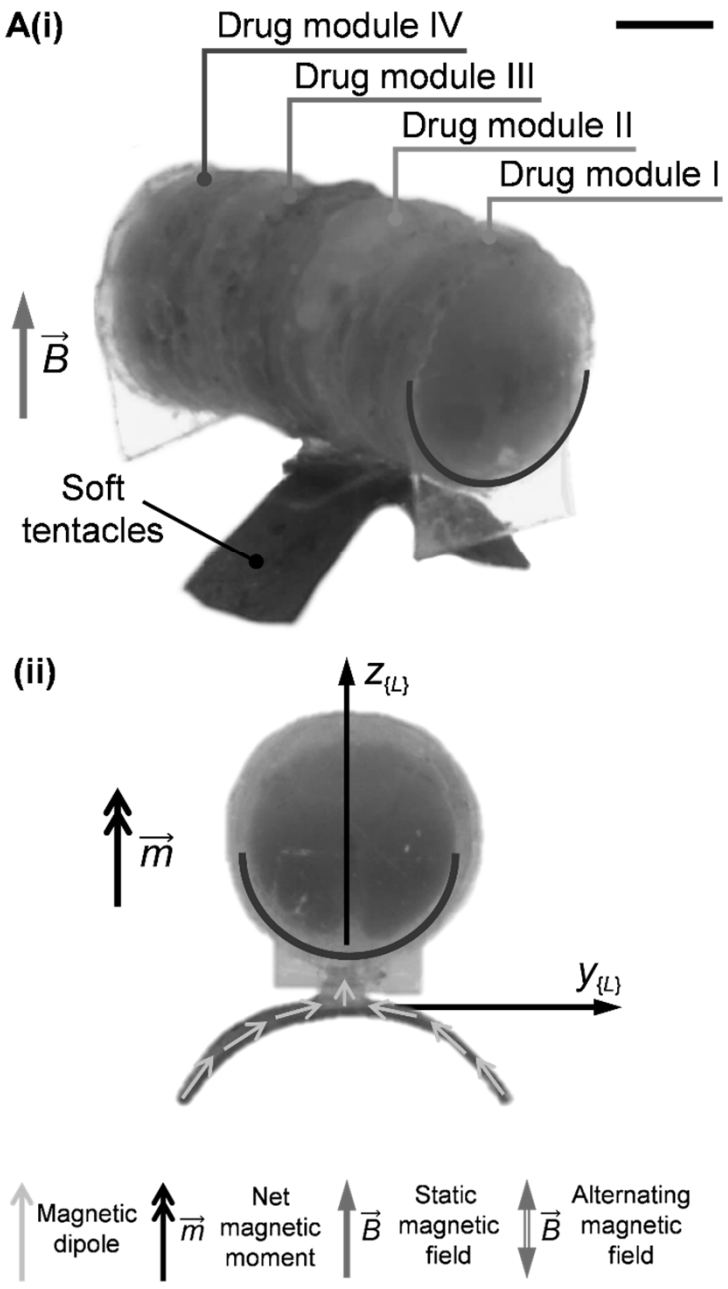

A(i)
Drug module IV
Drug module III
Drug module II
Drug module I
$\vec{B}$
Soft tentacles
(ii)
$z_{\{L\}}$
$\vec{m}$
$y_{\{L\}}$
Magnetic dipole
$\vec{m}$ Net magnetic moment
$\vec{B}$ Static magnetic field
$\vec{B}$ Alternating magnetic field

FIG. 12A

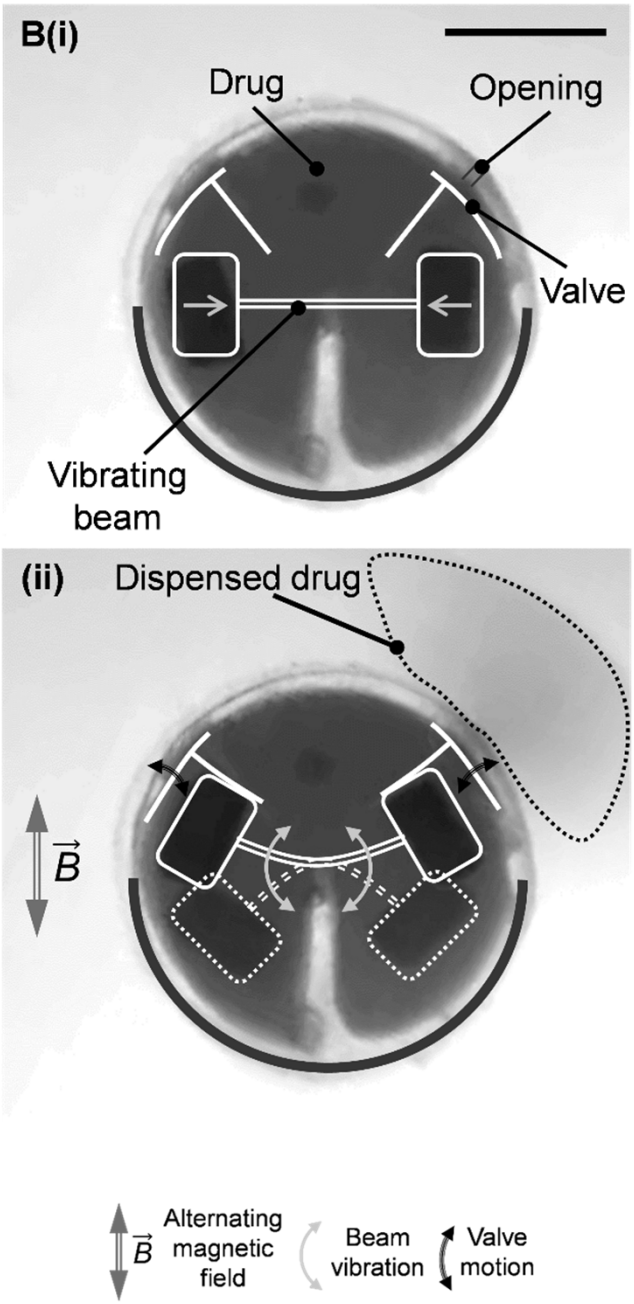

B(i)
Drug
Opening
Valve
Vibrating beam
(ii)
Dispensed drug
$\vec{B}$
$\vec{B}$ Alternating magnetic field
Beam vibration
Valve motion

FIG. 12B

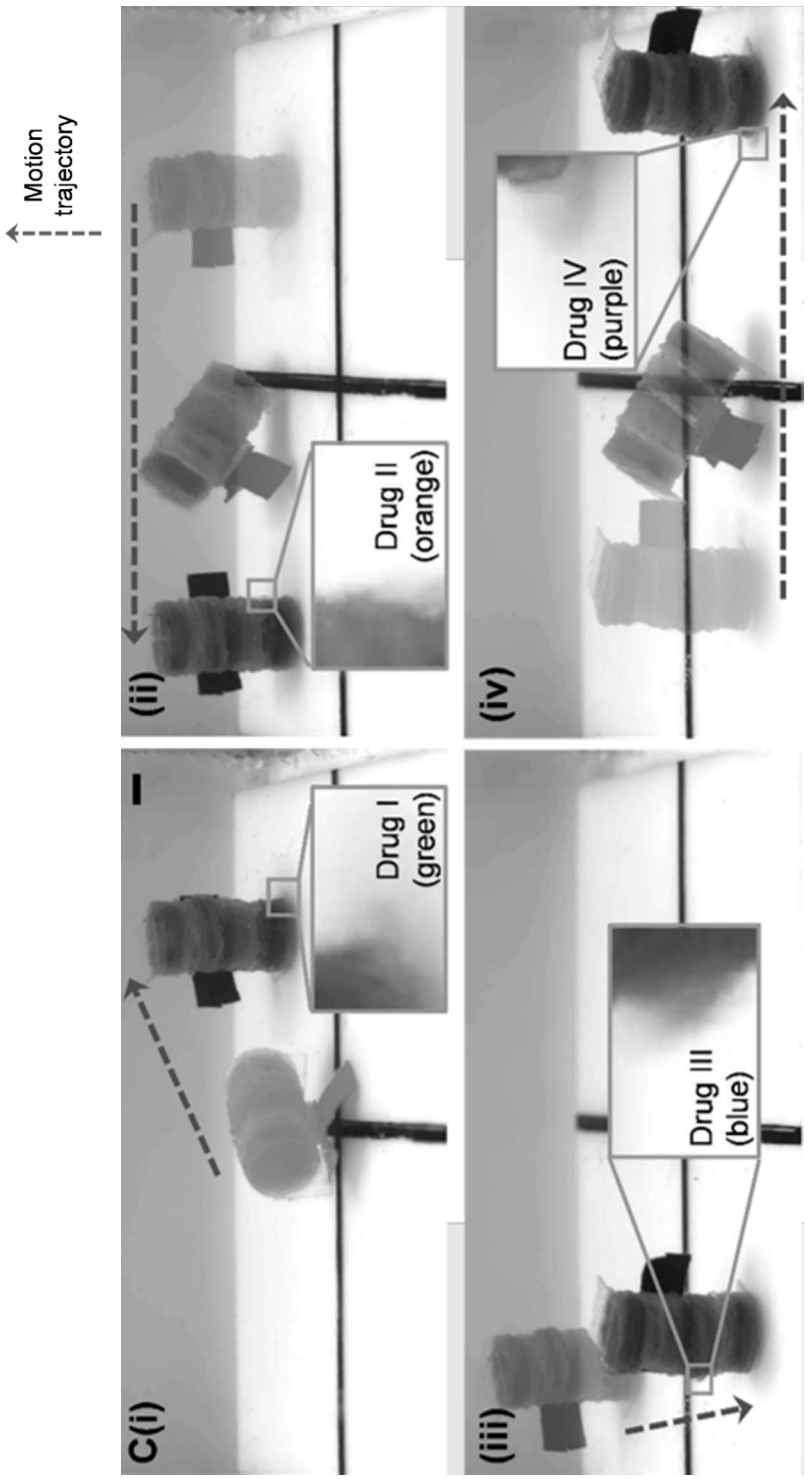

Motion trajectory
C(i)
Drug I (green)
(ii)
Drug II (orange)
(iii)
Drug III (blue)
(iv)
Drug IV (purple)

FIG. 12C

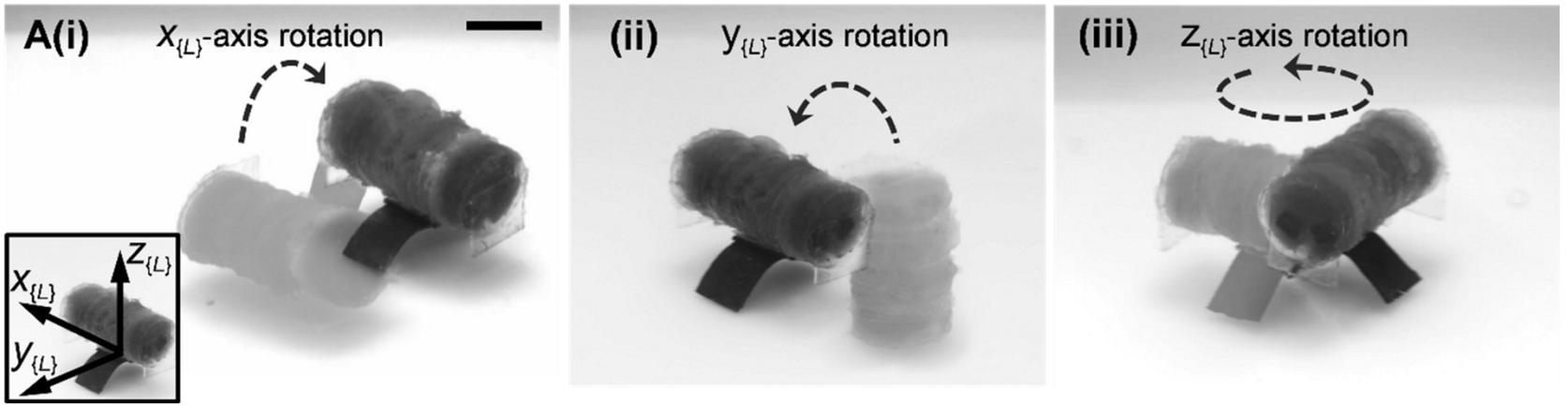


FIG. 13A

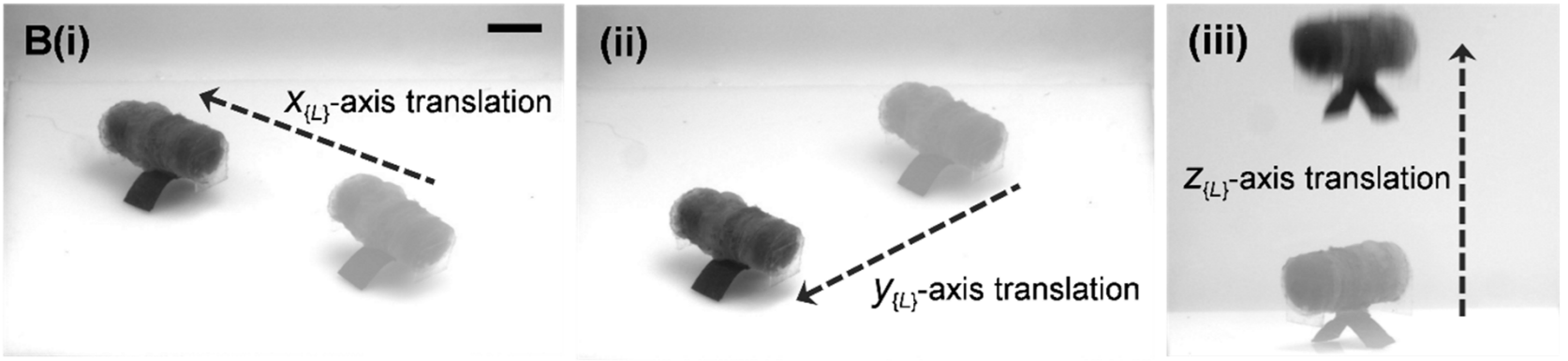


FIG. 13B

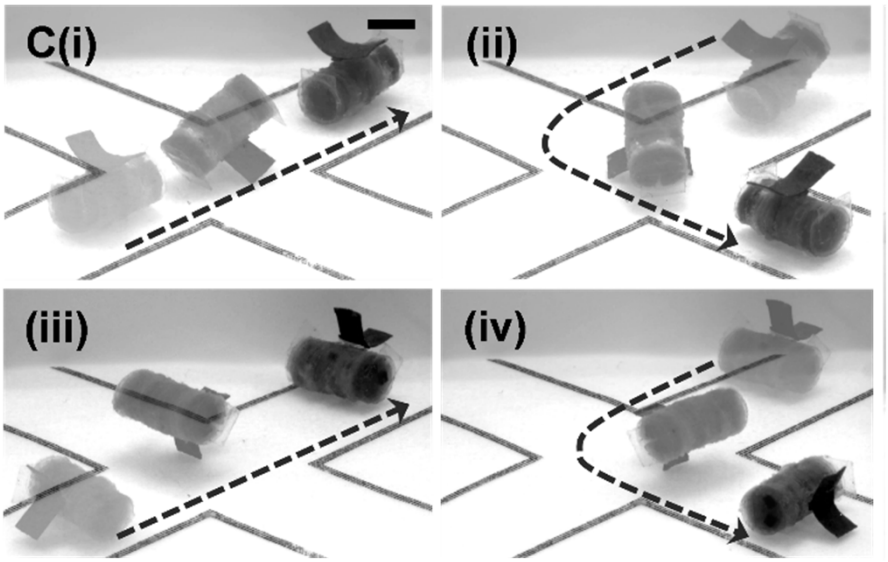


FIG. 13C

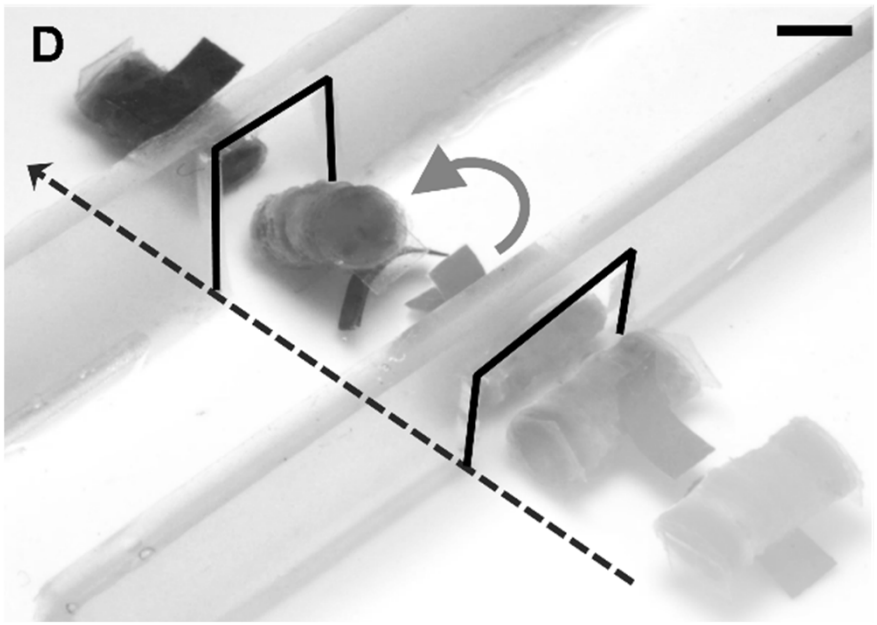


FIG. 13D

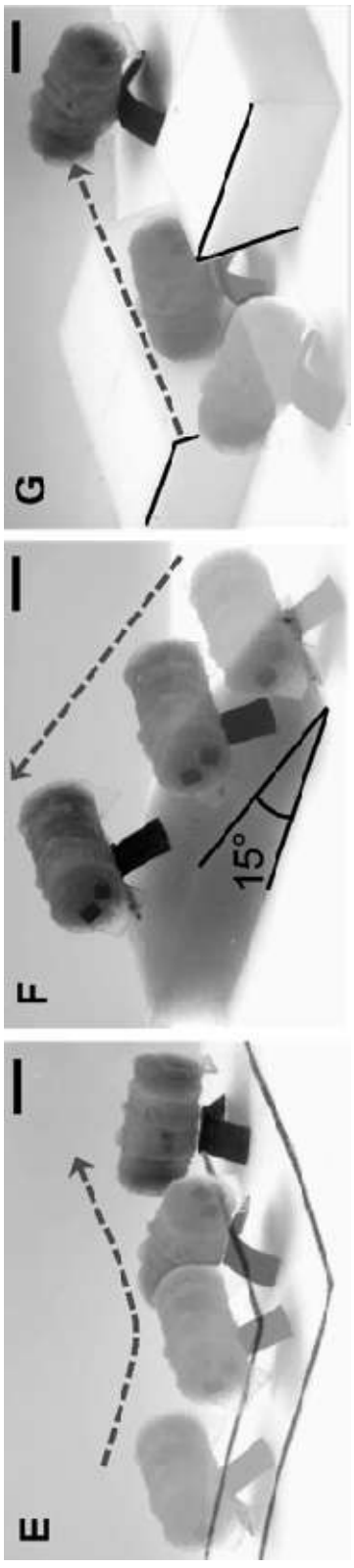


FIG. 13G

FIG. 13F

FIG. 13E

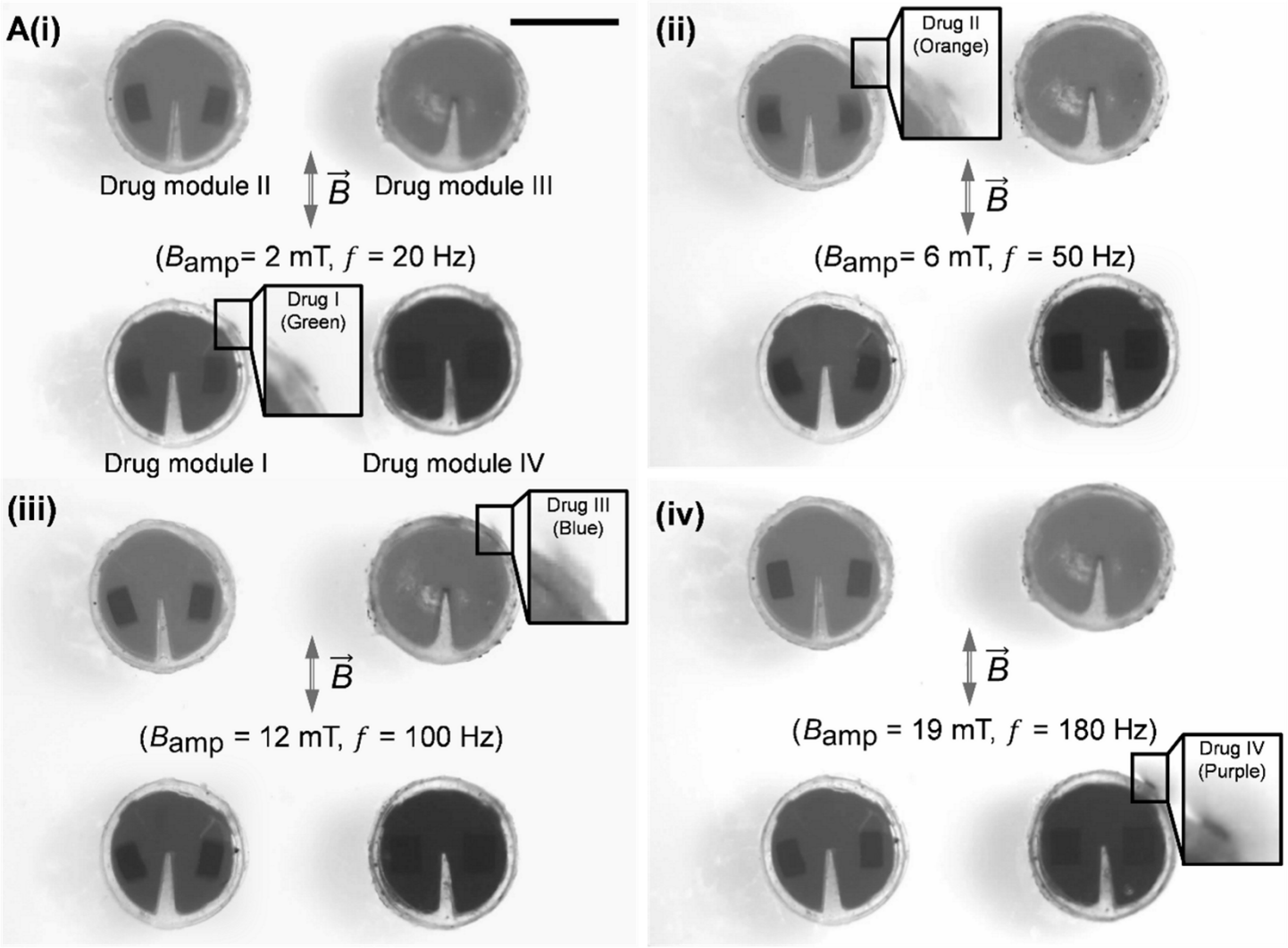

A(i)
Drug module II
Drug module III
(B_{amp}= 2 mT, f = 20 Hz)
Drug I (Green)
Drug module I
Drug module IV
(ii)
Drug II (Orange)
(B_{amp}= 6 mT, f = 50 Hz)
(iii)
Drug III (Blue)
(B_{amp} = 12 mT, f = 100 Hz)
(iv)
(B_{amp} = 19 mT, f = 180 Hz)
Drug IV (Purple)

FIG. 14A

B

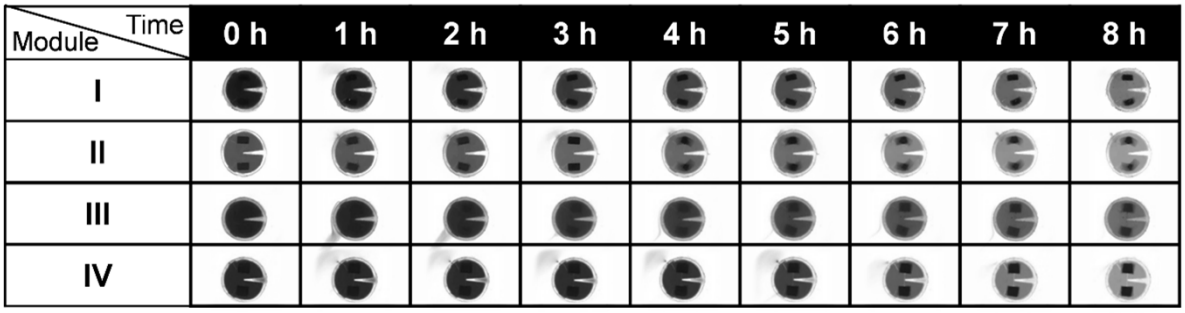


FIG. 14B

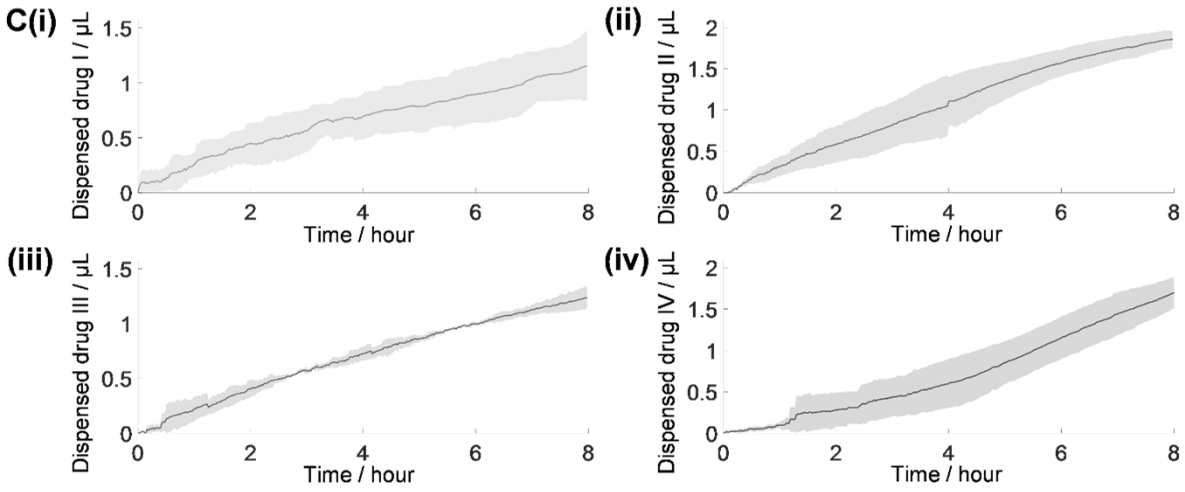


FIG. 14C

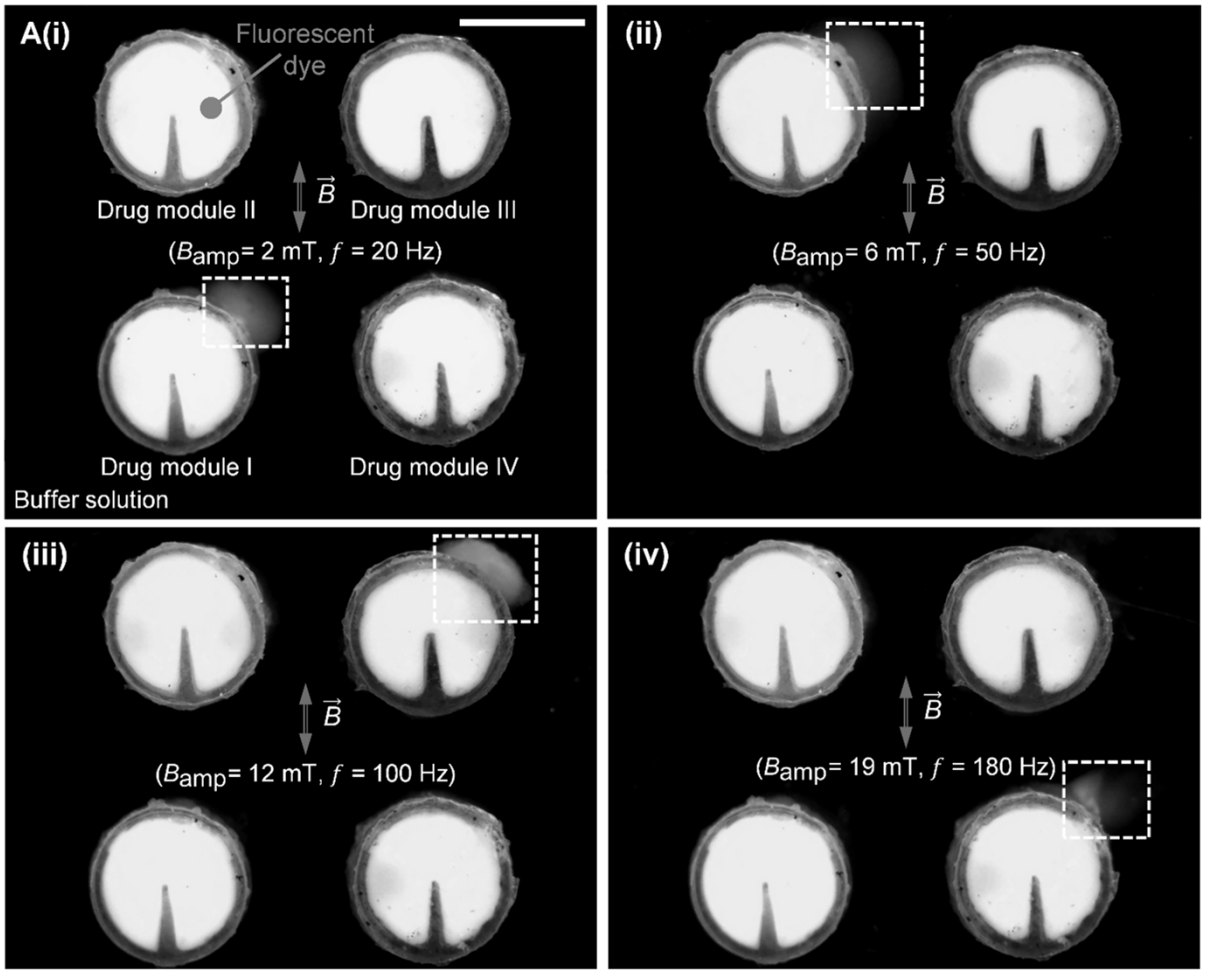


FIG. 15A

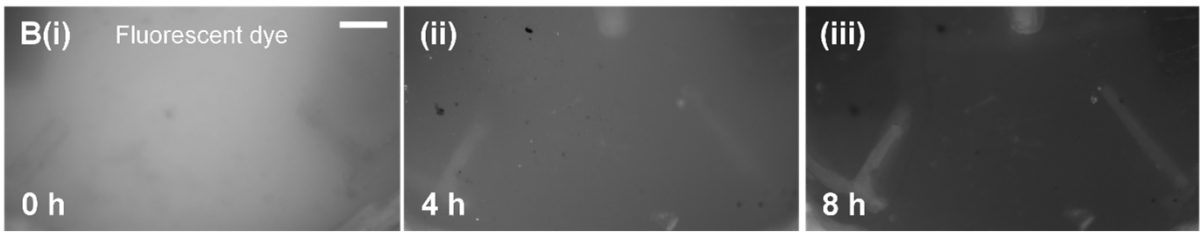


FIG. 15B

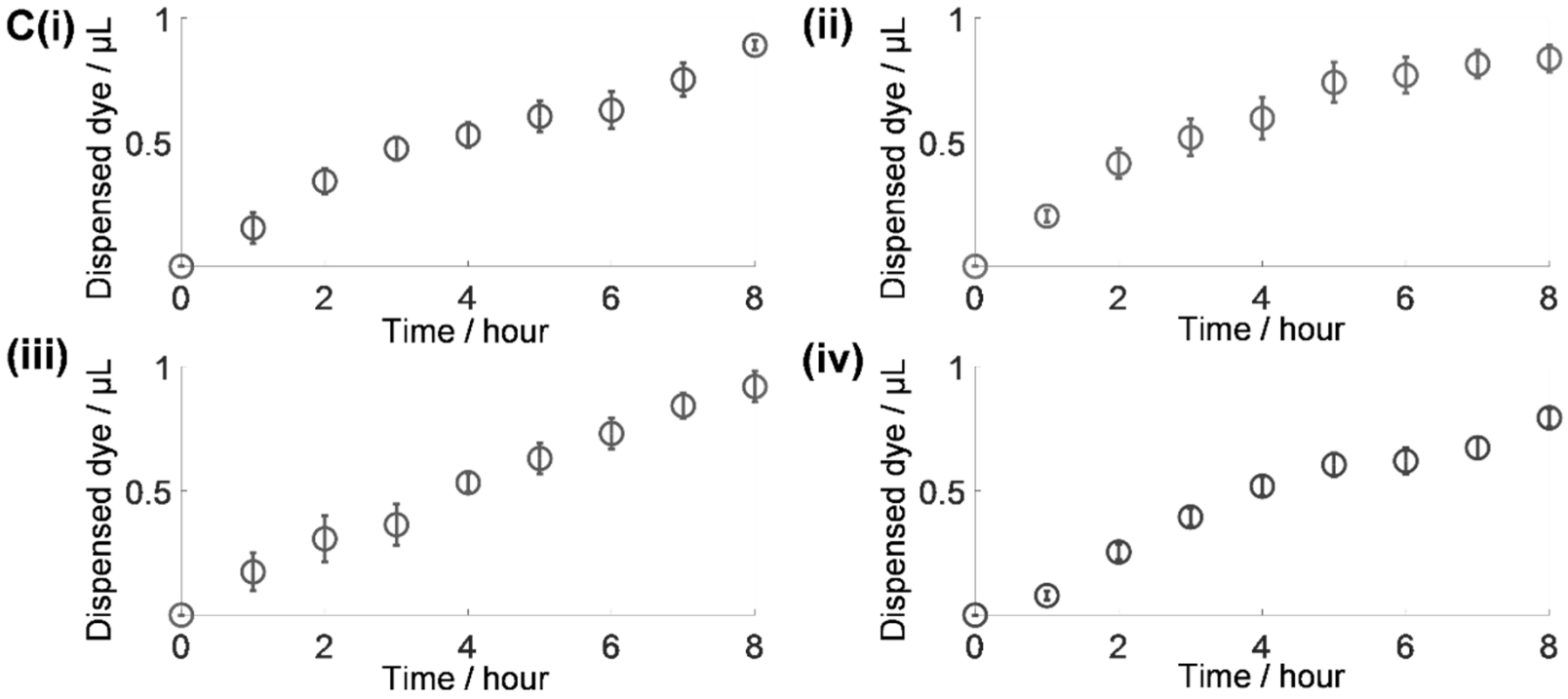


FIG. 15C

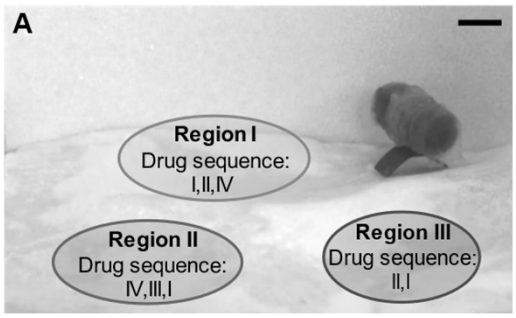


FIG. 16A

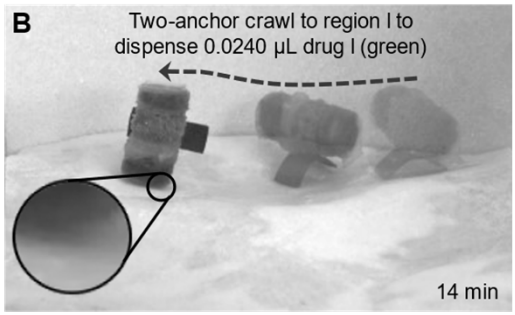


FIG. 16B

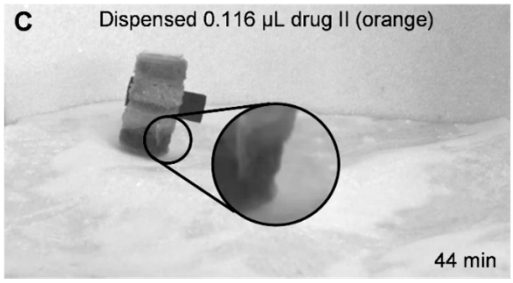


FIG. 16C

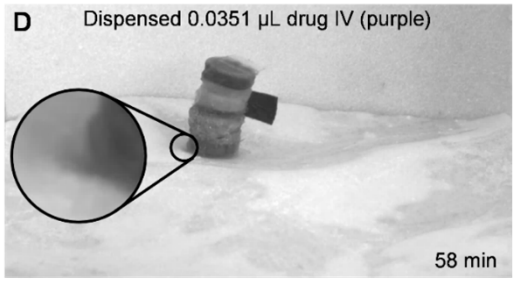


FIG. 16D

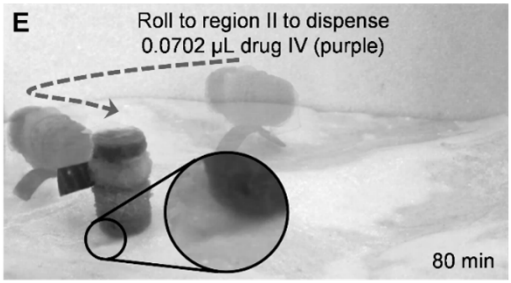


FIG. 16E

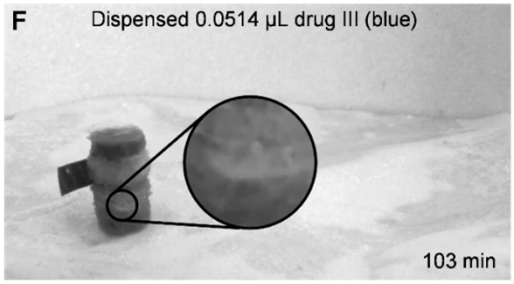


FIG. 16F

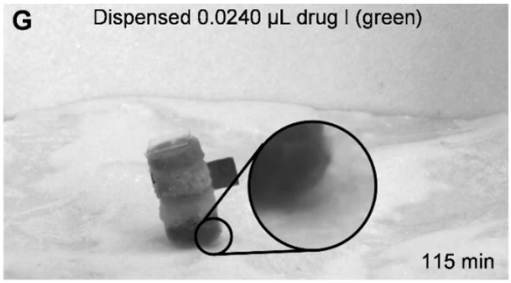


FIG. 16G

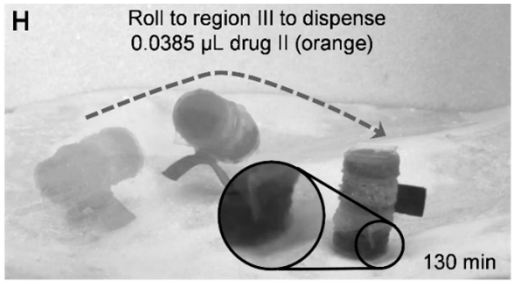


FIG. 16H

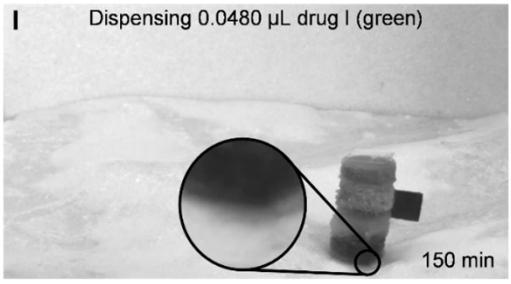


FIG. 16I

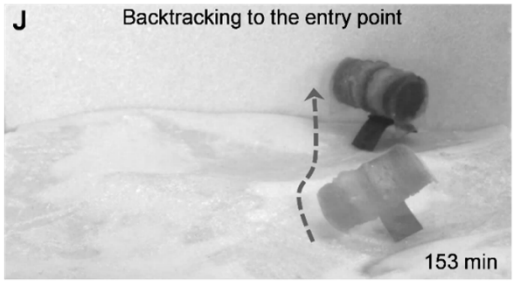


FIG. 16J

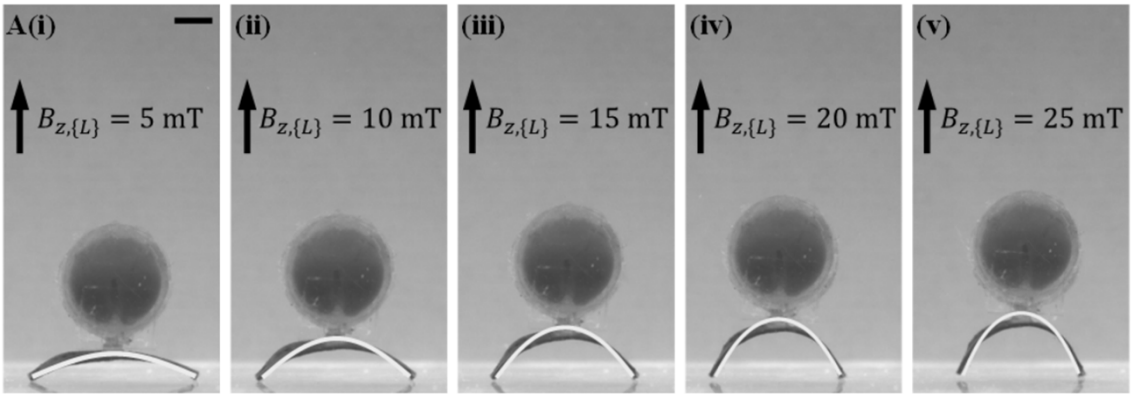


FIG. 17A

B

$B_{z,\{L\}}$	1 mT	5 mT	10 mT	15 mT	20 mT	25 mT
Drug module I						
Drug module II						
Drug module IIII						
Drug module IV						

FIG. 17B

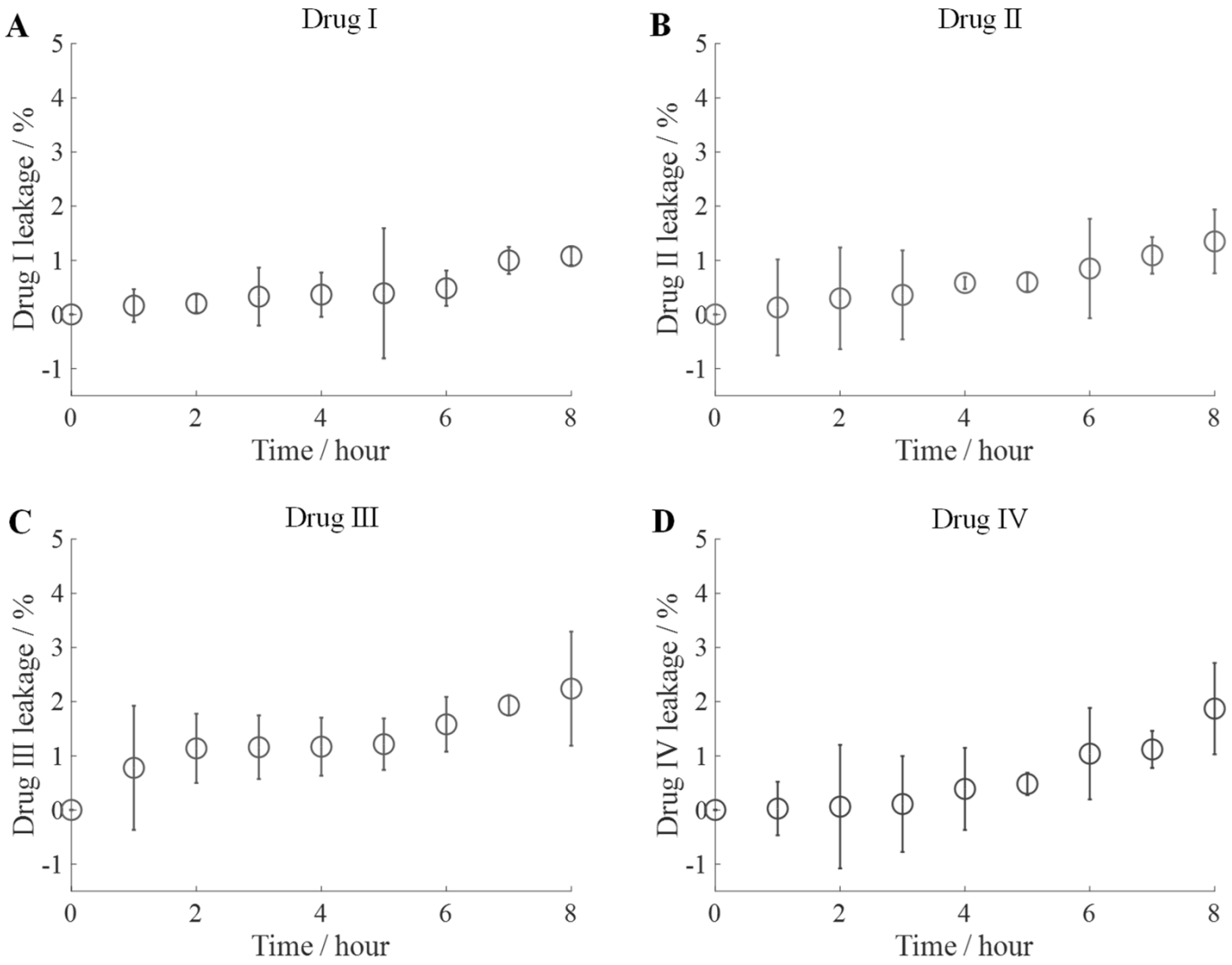

A
Drug I
Drug I leakage / %
Time / hour
B
Drug II
Drug II leakage / %
Time / hour
C
Drug III
Drug III leakage / %
Time / hour
D
Drug IV
Drug IV leakage / %
Time / hour

FIG. 18

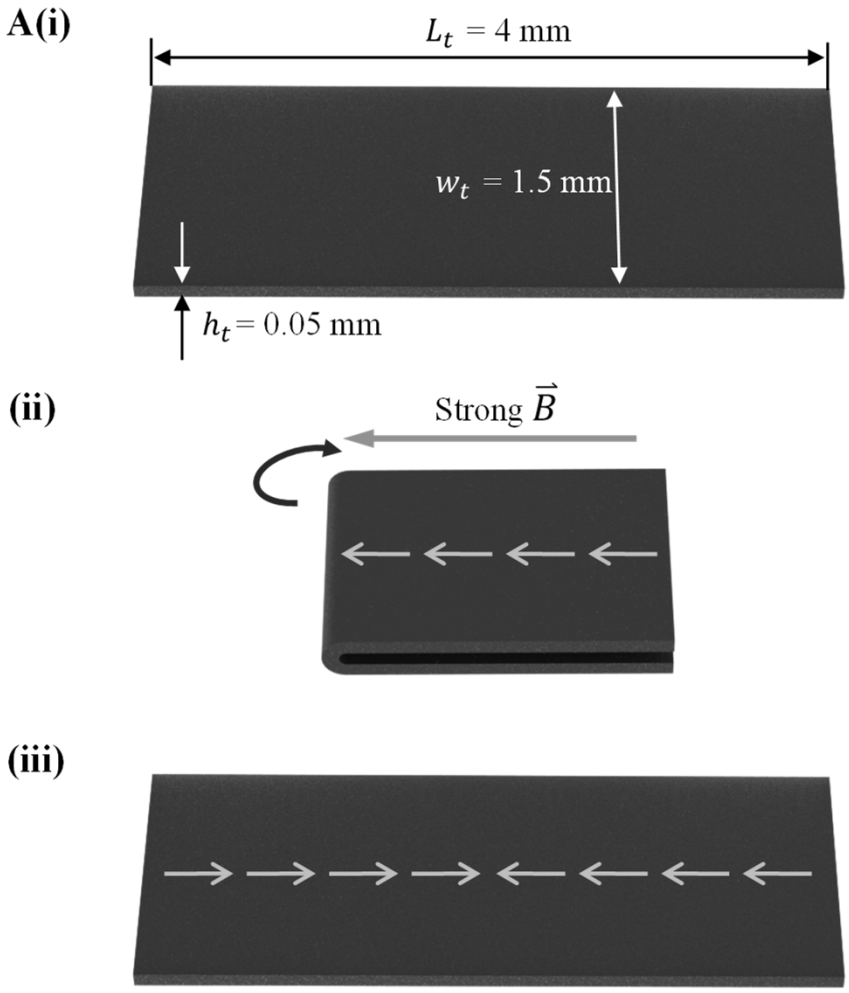


FIG. 19A

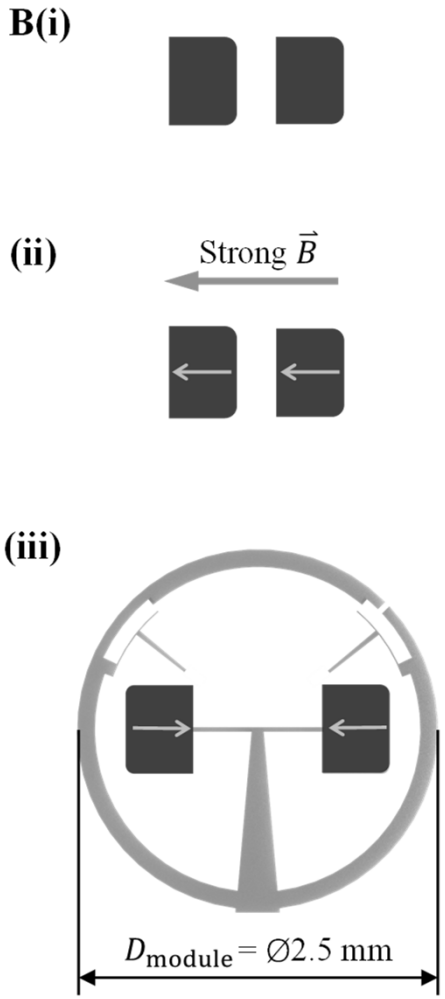


FIG. 19B

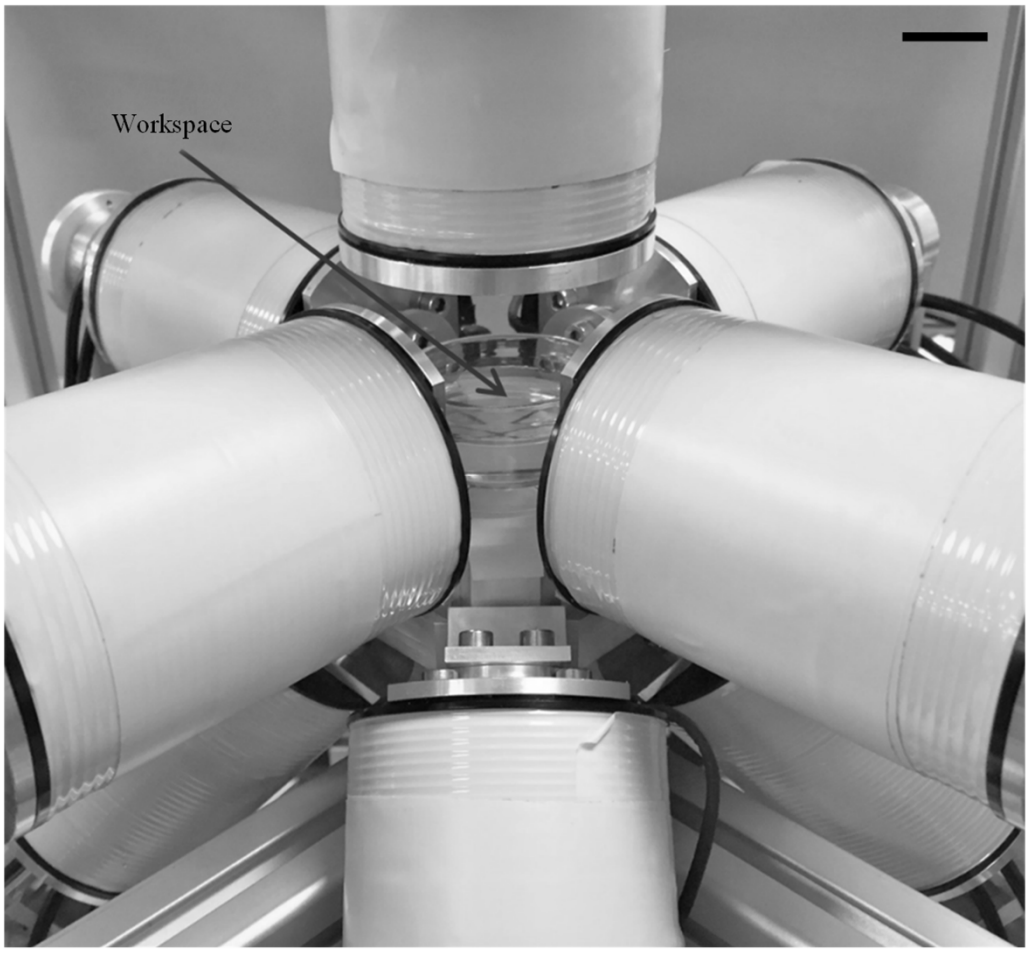


FIG. 20



FIG. 21A

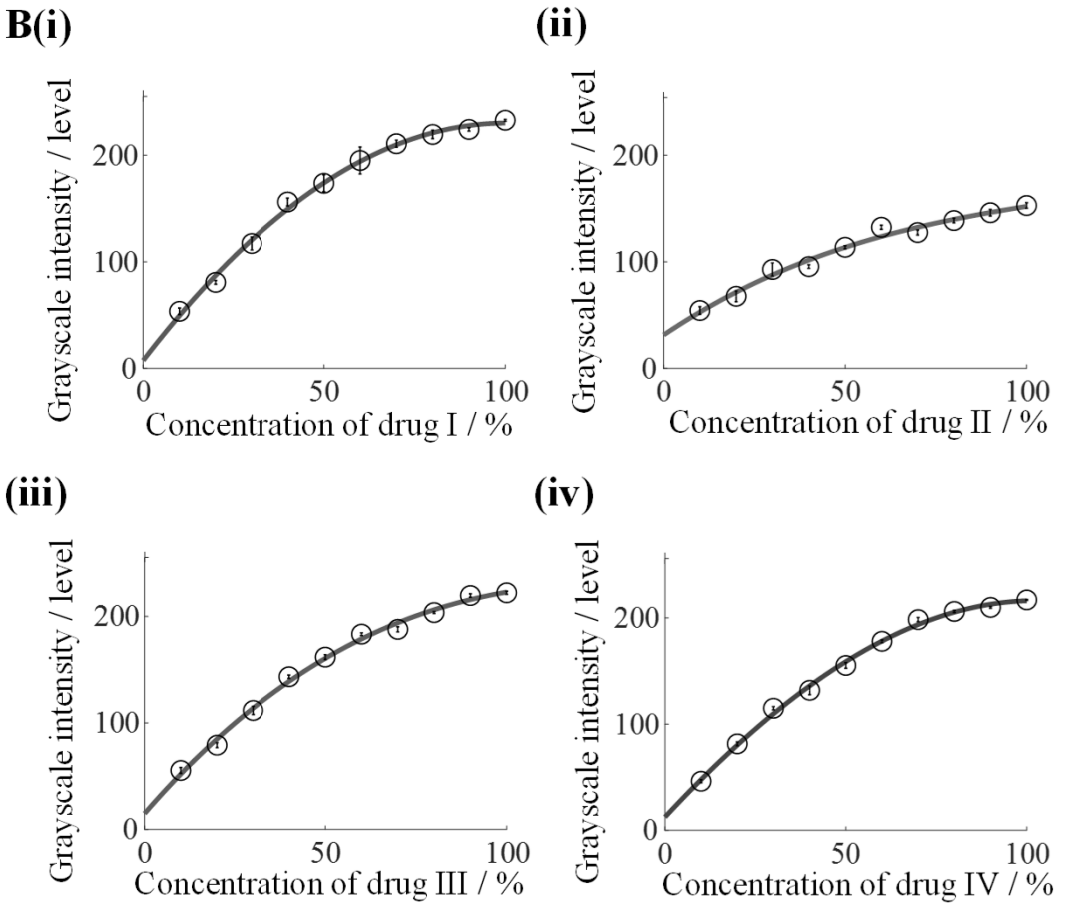


FIG. 21B

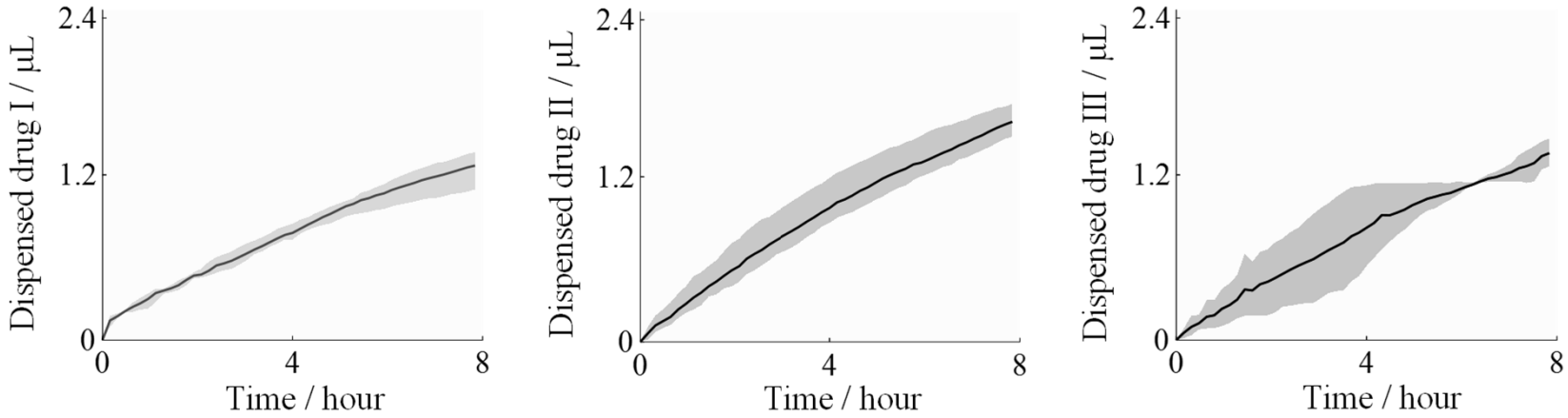

Dispensed drug I / μL
2.4
1.2
0
0
4
8
Time / hour
Dispensed drug II / μL
2.4
1.2
0
0
4
8
Time / hour
Dispensed drug III / μL
2.4
1.2
0
0
4
8
Time / hour

FIG. 22

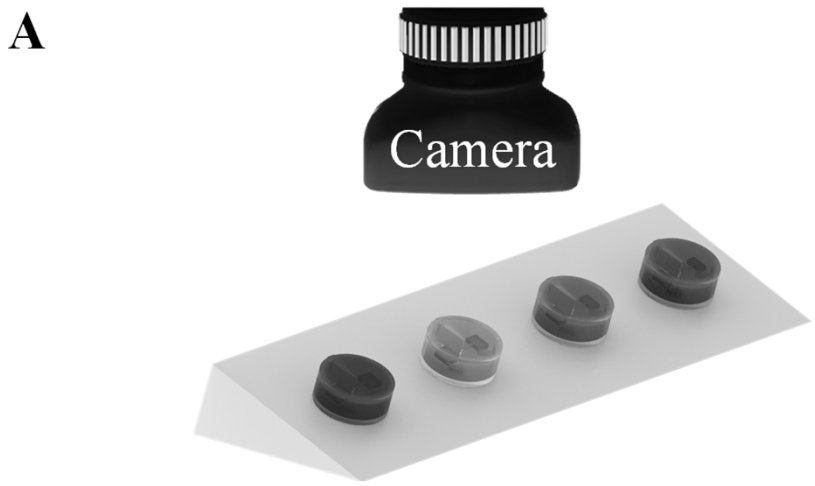


FIG. 23A

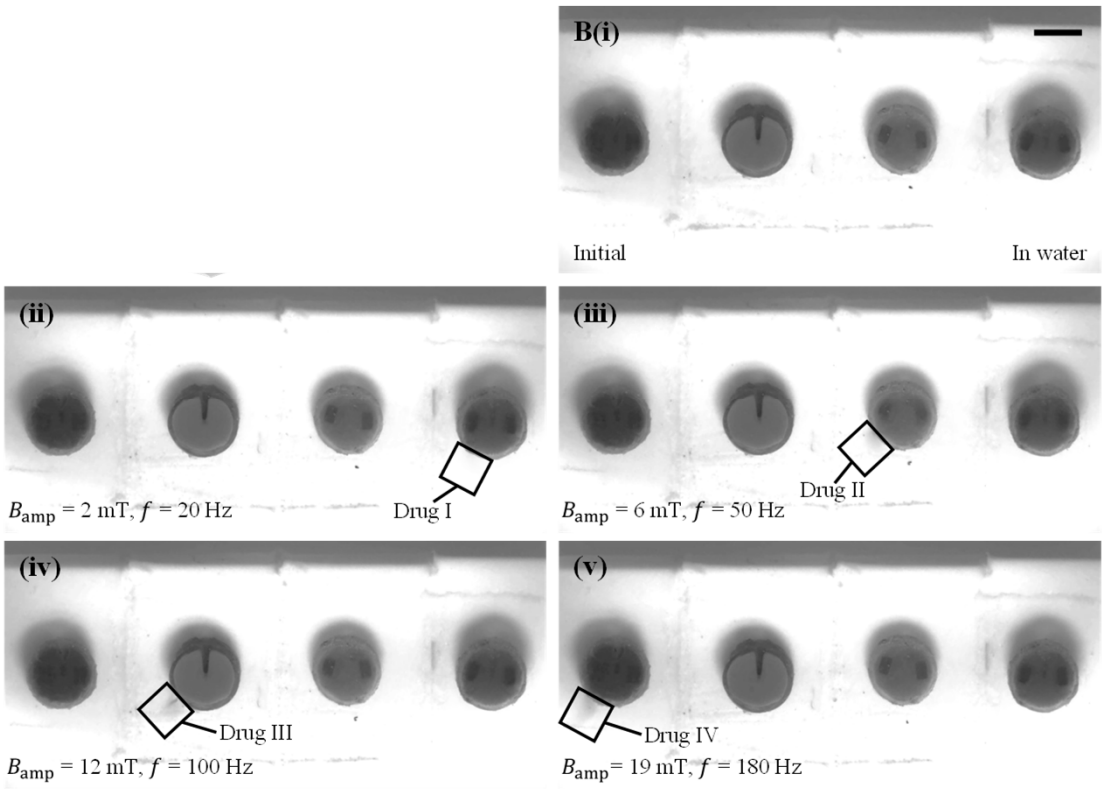


FIG. 23B

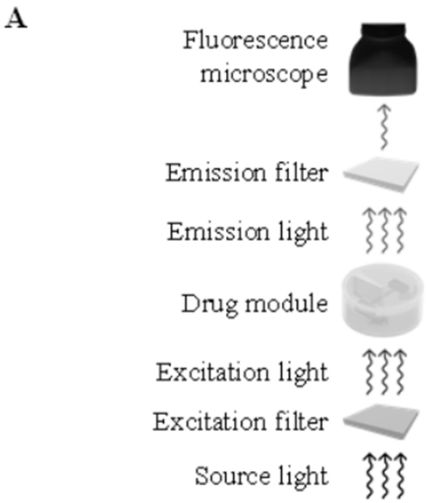


FIG. 24A

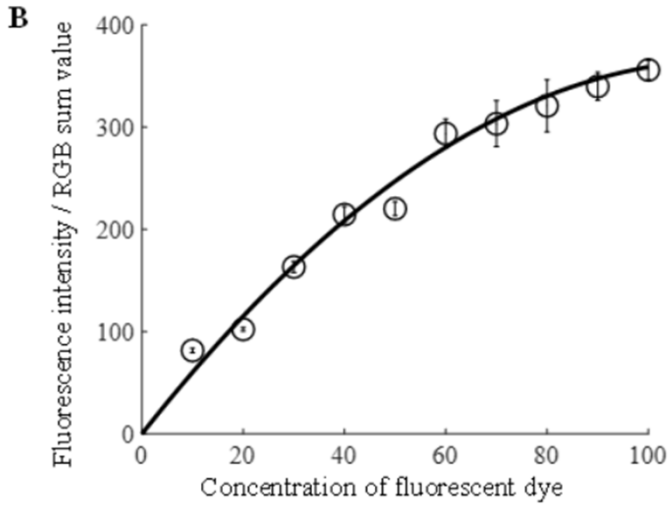


FIG. 24B

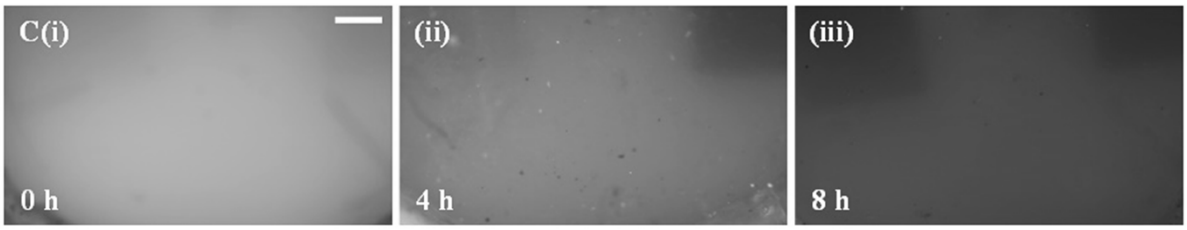


FIG. 24C

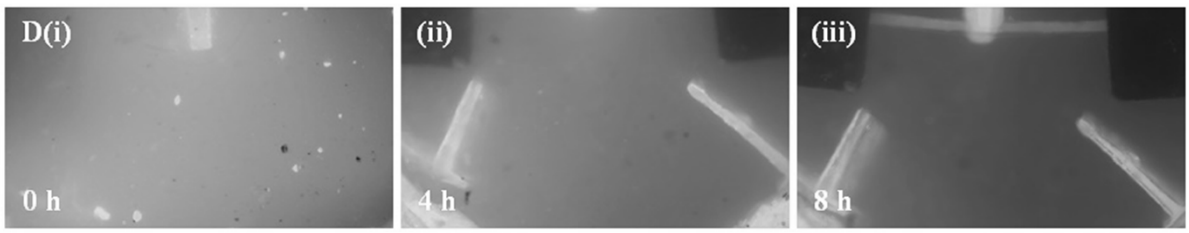


FIG. 24D



FIG. 24E

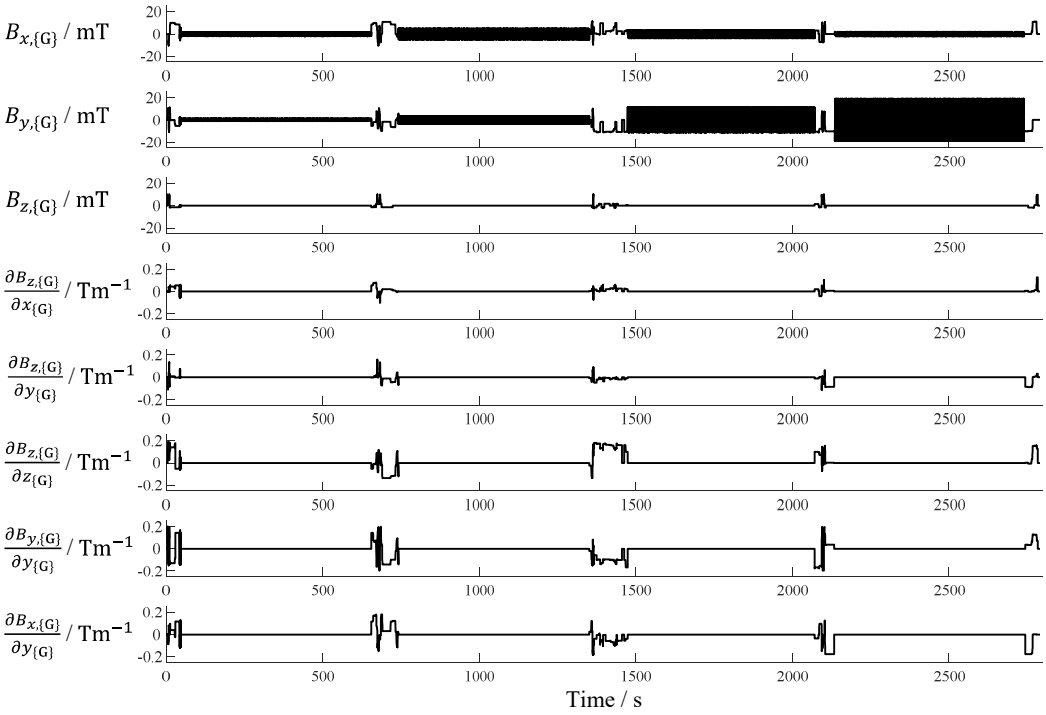

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
Time / s

FIG. 25

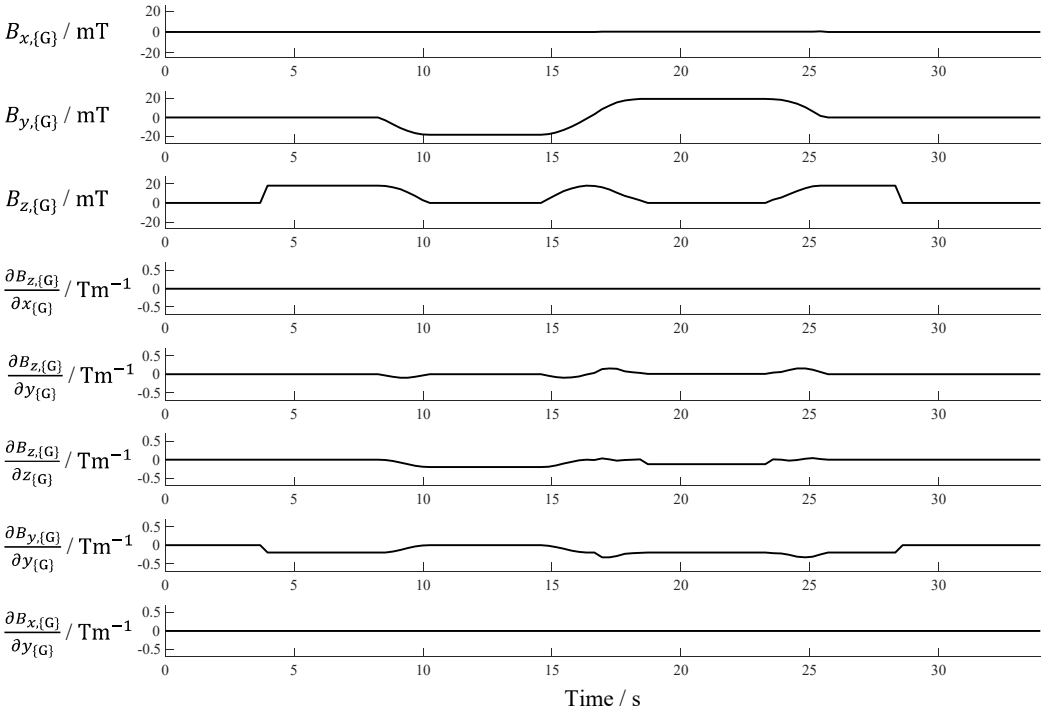

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
Time / s

FIG. 26

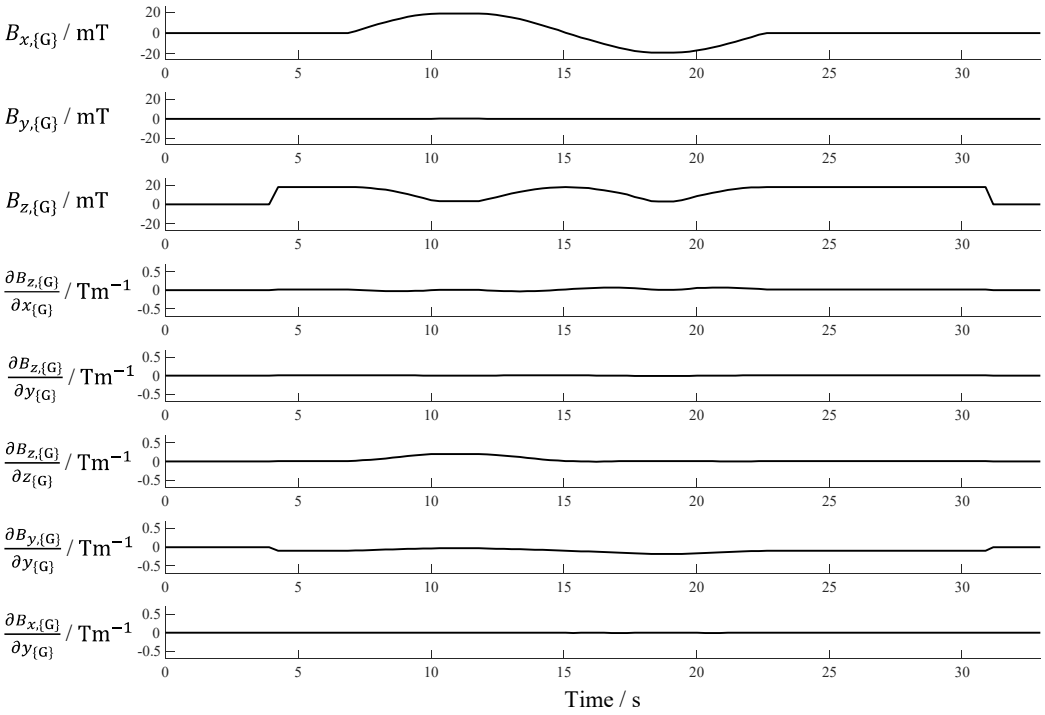

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
Time / s

FIG. 27

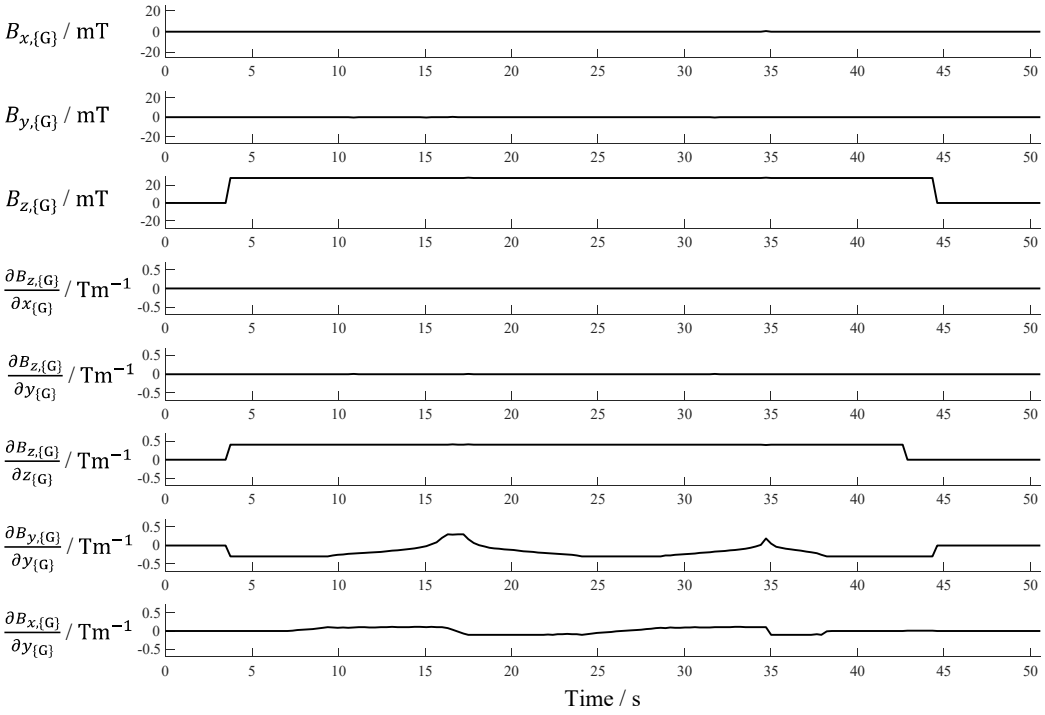

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
Time / s

FIG. 28

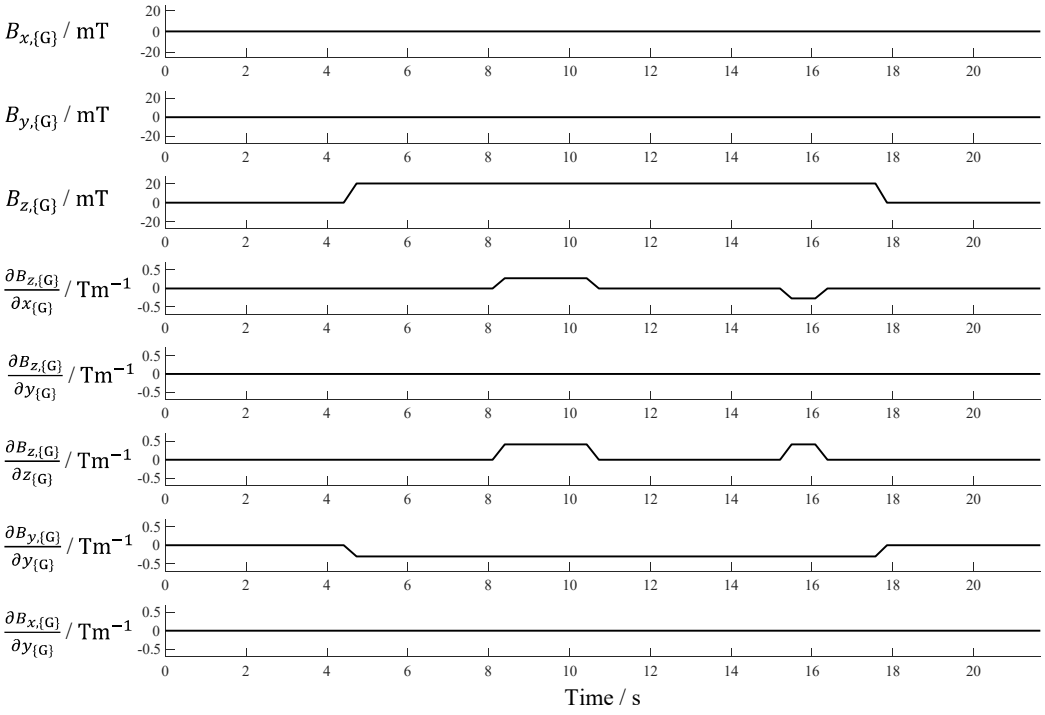

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 29

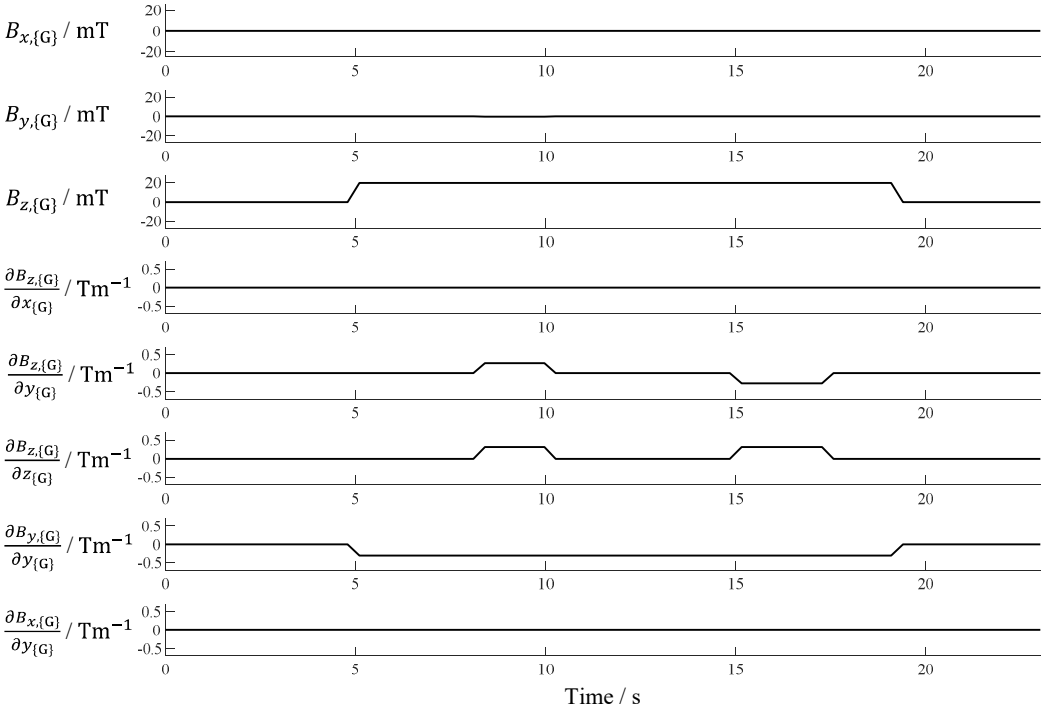

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 30

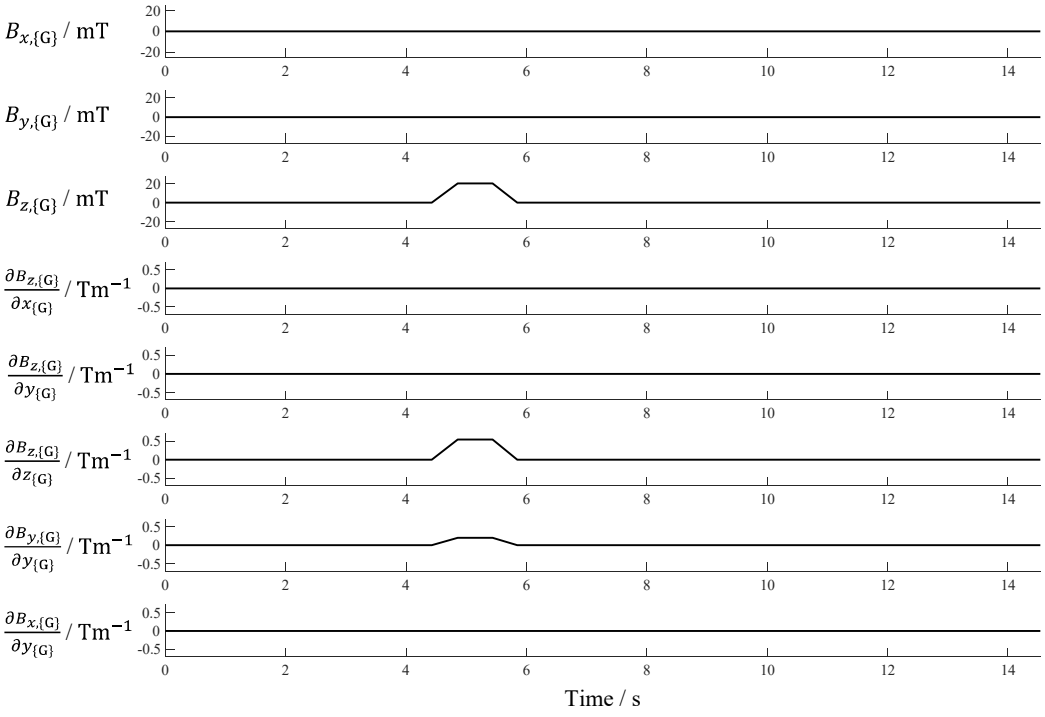

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 31

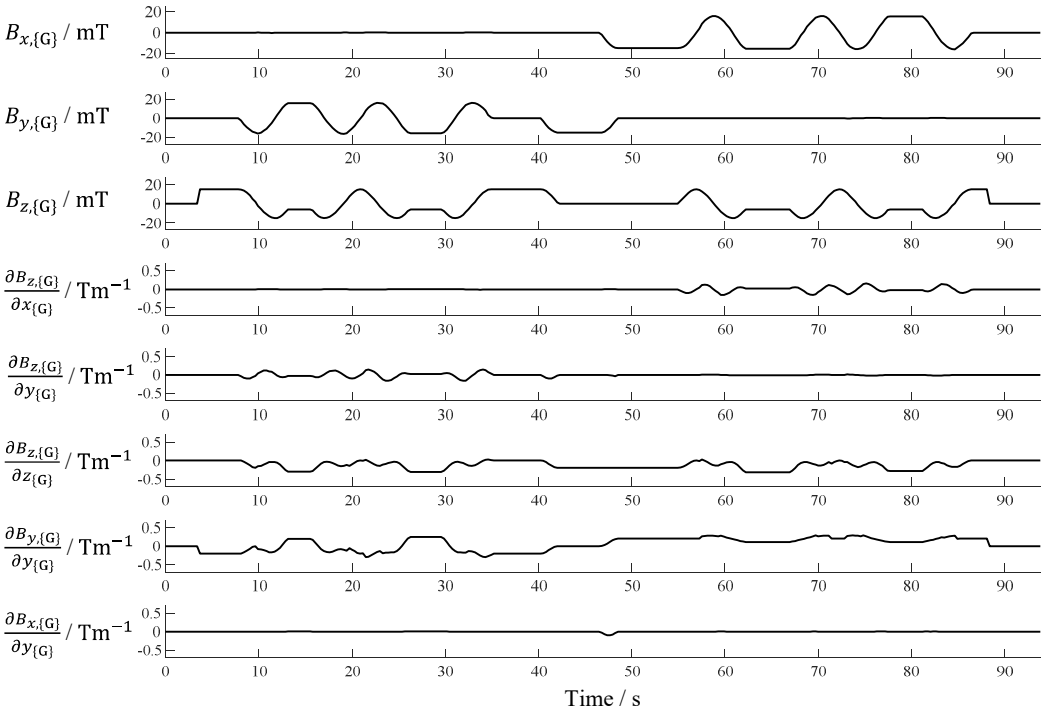

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 32

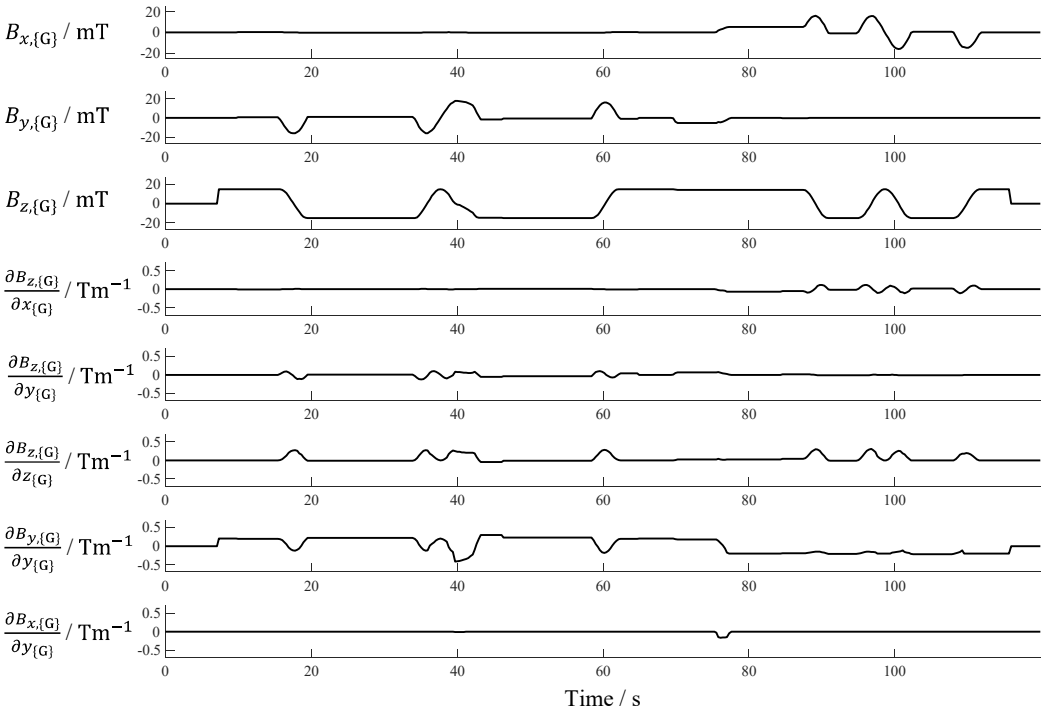

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 33

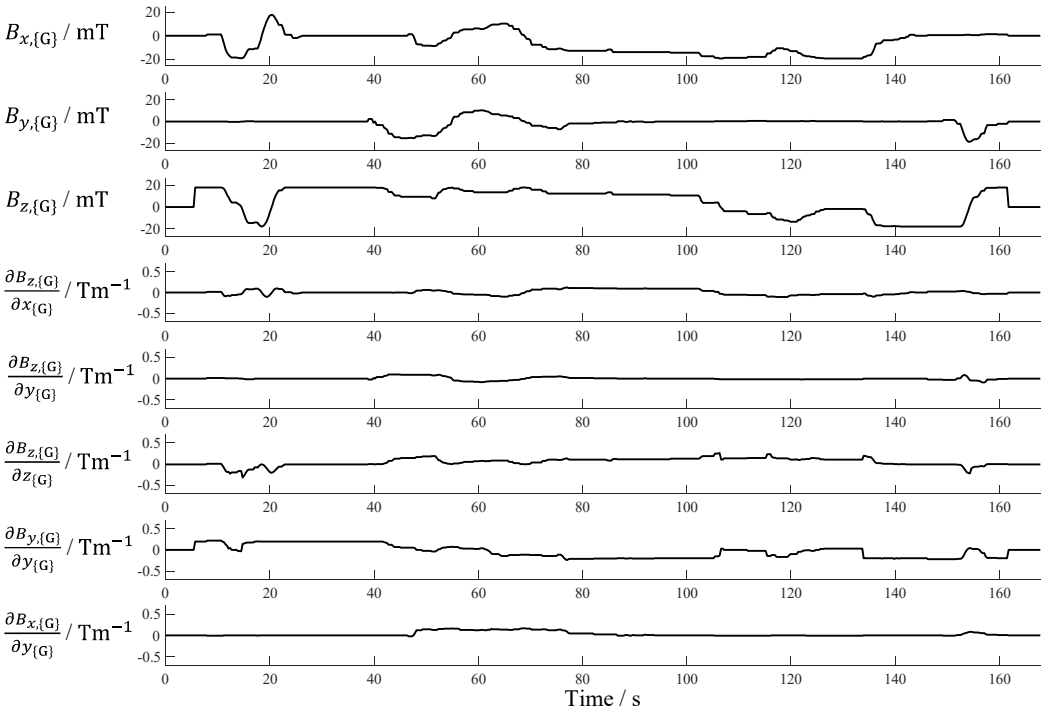

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 34

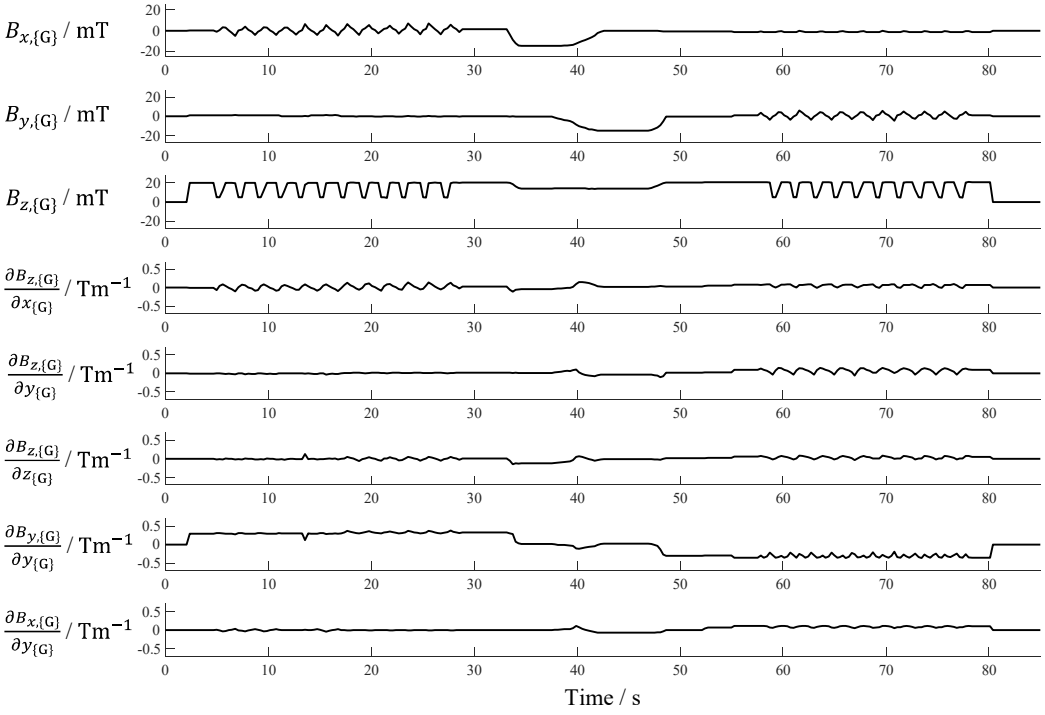

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 35

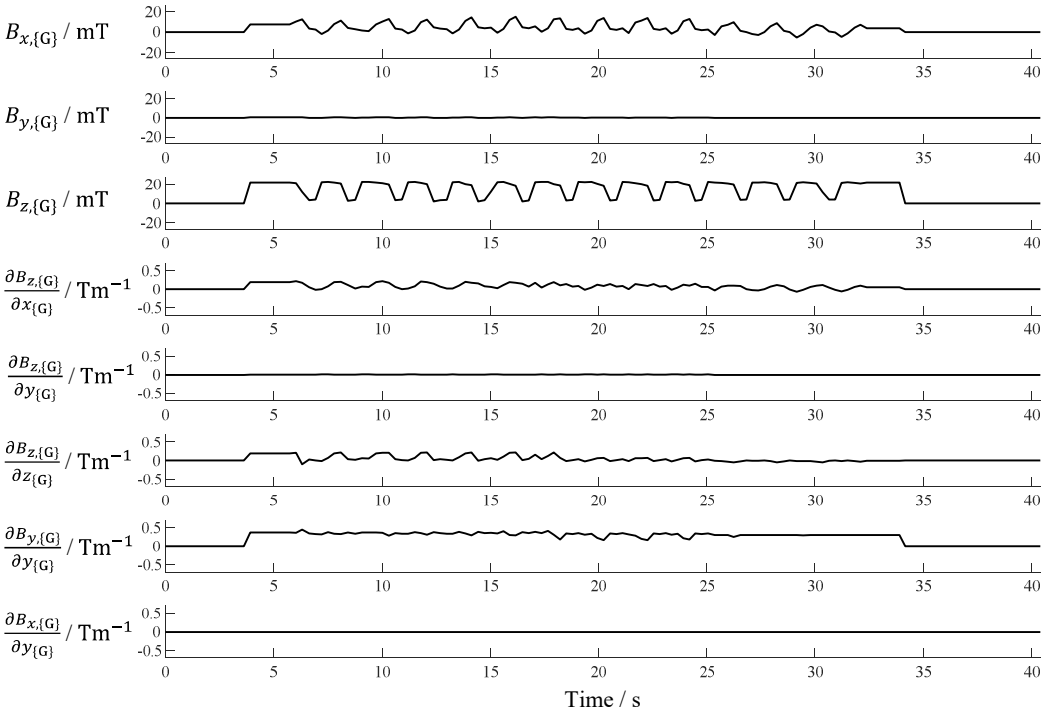

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / $\mathrm{Tm^{-1}}$
Time / s

FIG. 36

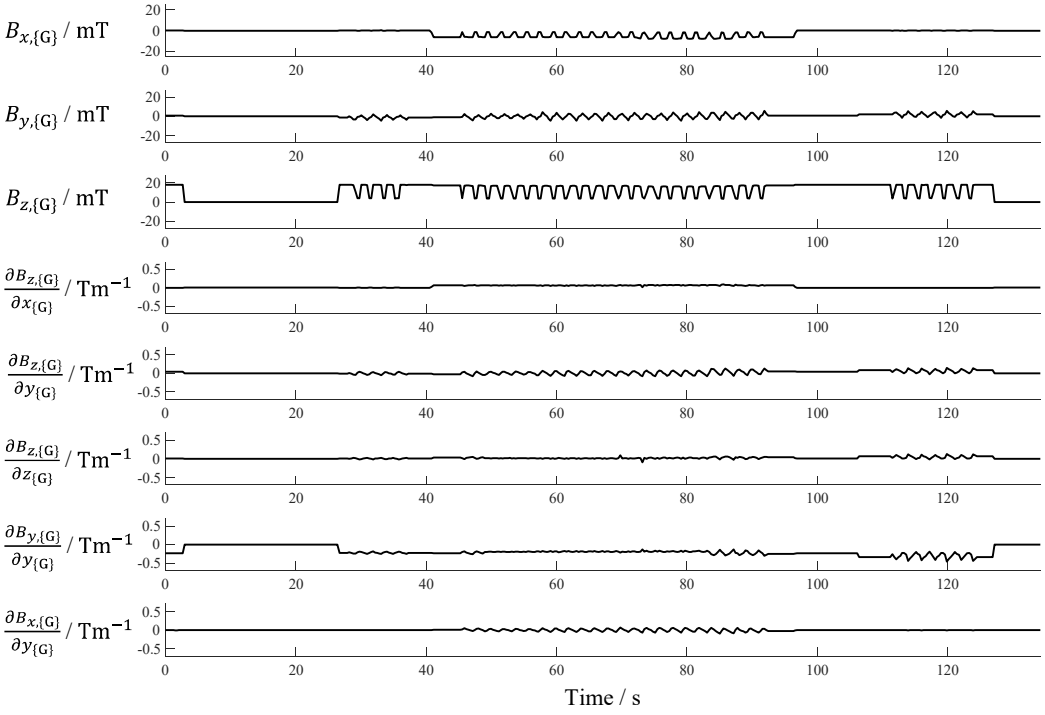

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
Time / s

FIG. 37

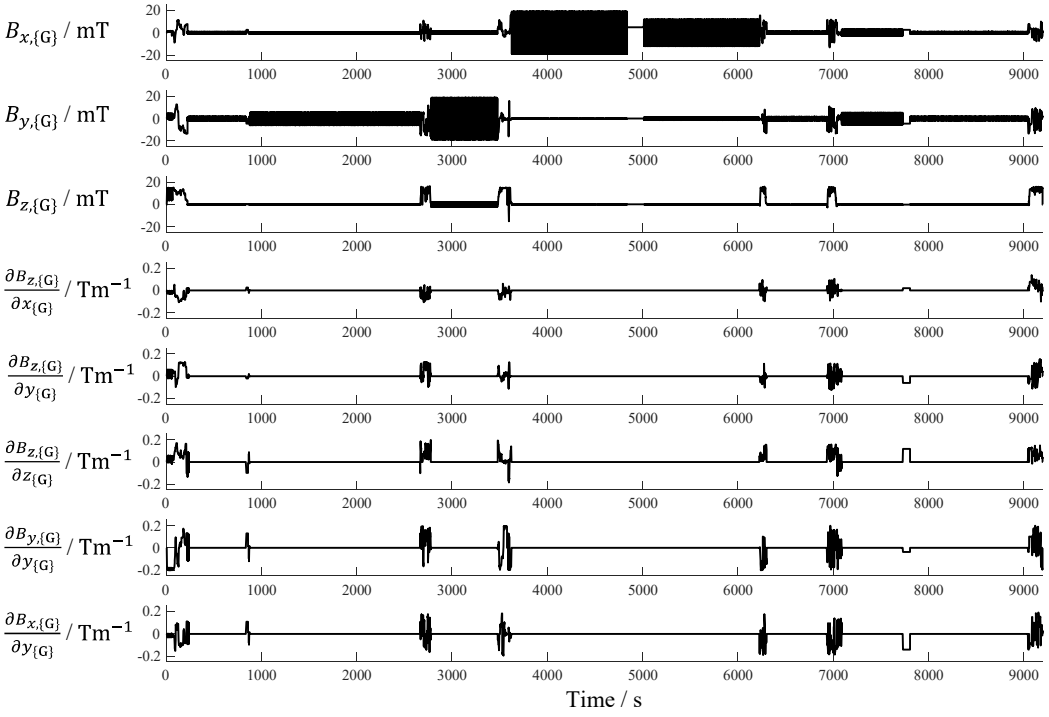

$B_{x,\{G\}}$ / mT
$B_{y,\{G\}}$ / mT
$B_{z,\{G\}}$ / mT
$\frac{\partial B_{z,\{G\}}}{\partial x_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{z,\{G\}}}{\partial z_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{y,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
$\frac{\partial B_{x,\{G\}}}{\partial y_{\{G\}}}$ / Tm^{-1}
Time / s

FIG. 38